Ecological Overview of Musquash Estuary: a Proposed Marine Protected Area

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Ecological Overview of Musquash Estuary: a Proposed Marine Protected Area

by

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ABSTRACT

Singh, R., M. I. Buzeta, M. Dowd, J. L. Martin, and M. LeGresley. 2000. Ecological overview of Musquash Estuary: a proposed marine protected area. Can. Manusc. Rep. Fish. Aquat. Sci. 2538: 39 p.

Musquash Estuary is located approximately 20 km west of the city of Saint John, New Brunswick. It was recently designated as an Area of Interest, the first milestone in the official Marine Protected Areas (MPA) process. This manuscript presents a summary of the published and unpublished scientific studies for the area. Existing data with geographic references were plotted on maps of the estuary. These provide a start for the development of a GIS database for the area. This overview provides a summary of the current literature, the various studies initiated (hydrography, plankton, species inventories), and those planned. Studies on the physical oceanography of the estuary, initiated in the summer of 1999, indicate water properties that were generally homogenous in the vertical, but with some stratification in Five Fathom Hole. The estuary is a highly productive area and supports a variety of species. The salt marsh is comprised of the common marsh plant species while the characteristic zonation of species in the rocky intertidal zone occurs at Musquash Head. Many rare, very rare, and migrant species of birds visit the estuary. DFO is studying this coastal ecosystem to help understand the function and role of the estuary in the Bay of Fundy ecosystem and to assist in the development of an appropriate management plan.

RÉSUMÉ

Singh, R., M. I. Buzeta, M. Dowd, J. L. Martin, and M. LeGresley. 2000. Ecological overview of Musquash Estuary: a proposed marine protected area. Can. Manusc. Rep. Fish. Aquat. Sci. 2538: 39 p.

L'estuaire de la Musquash se situe à environ 20 kilomètres à l'ouest de la ville de Saint John, au Nouveau-Brunswick. Il a récemment été désigné comme zone d'intérêt, la première étape du processus officiel d'établissement d'une zone de protection marine (ZPM). Le rapport présente une liste sommaire des études scientifiques publiées et inédites visant la région. Les données existantes liées à des points de repères géographiques ont été ajoutées à des cartes de l'estuaire. Il s'agit des premières démarches dans l'élaboration de la base de données d'un SIG pour ce secteur. L'aperçu présente un sommaire de la documentation actuelle ainsi que les diverses études en cours (hydrographie, plancton et dénombrement des espèces) et celles prévues. Des études sur l'océanographie physique de l'estuaire lancées à l'été de 1999 démontrent que les propriétés de l'eau sont assez homogènes sur le plan vertical, mais qu'il y a une certaine stratification dans la baie Five Fathom Hole. L'estuaire est un secteur très productif où vivent diverses espèces. On retrouve dans le marais d'eau salée les espèces végétales habituelles, alors que la zonation caractéristique des espèces dans la zone intertidale rocheuse peut être constatée au cap Musquash. De nombreuses espèces d'oiseaux rares ou très rares et d'oiseaux migrateurs visitent l'estuaire. Le MPO étudie cet écosystème côtier afin de mieux comprendre la fonction et le rôle de l'estuaire dans l'écosystème de la baie de Fundy et pour faciliter l'élaboration d'un plan de gestion convenable.

INTRODUCTION

On February 8, 2000, the Department of Fisheries and Oceans announced publicly that Musquash Estuary had been accepted as an Area of Interest, the first milestone in the official Marine Protected Areas (MPA) process. Boundaries for the proposed MPA include all the subtidal and intertidal area inside a line drawn from Musquash Head through the southern tip of Gooseberry Island, and extending to the coastline at the western tip of Gooseberry Cove (Fig. 1). The inland limit will be the head of the tide at the Musquash Hydro Station. The estimated longitudes and latitudes for the boundaries of the proposed MPA as shown in Fig. 1 are as indicated in the table below. The estimated total area of the MPA is 1,656 ha (16.56 km^2, 6.39 mi^2).

The formation of the Musquash Marine Protected Areas Planning Group has facilitated community and stakeholder input into the management plan currently being developed. The overall objective of the management plan is the "protection and restoration of the Musquash Estuary and surrounding salt marshes", and the following goals have been identified:

- Maintaining biodiversity of the area.
- Maintaining a healthy fishing industry.
- Protecting highly productive habitats.
- Increasing the natural habitat and bird life in the marsh and surrounding land.
- Preserving the area for future generations.
- Ensuring the conservation and the sustainable use of the marsh.

In order to obtain the scientific information required for evaluation of this Area of Interest, as well as for the development of an appropriate management plan, DFO has summarized existing information. DFO will study further this coastal ecosystem to help understand the function and role of the estuary in the Bay of Fundy ecosystem. Studies initiated in the summer of 1999 will be useful as a basis for planning the subsequent comprehensive and coordinated effort at understanding the importance of the area. As well, DFO will contribute to the Musquash MPA Planning Group's assessment of activities and their impacts in and around the estuary.

This overview provides a summary of the current literature, the various studies initiated (hydrography, plankton, species inventories), and those planned. Figures. 2a and 2b show the locations of sampling and observation stations of some of the past (and more recent) studies in the Musquash Estuary that are described in this report.

BACKGROUND

In New Brunswick less than 3% of the total wetland is salt marsh (Environment Canada 1987), and the NB Wetlands Atlas identifies 8470 ha of salt marsh in the province (24% in upper Bay of Fundy (Chignecto Bay), and 13% in lower Bay of Fundy). Up to 65% of the salt marshes in NB (85% in Bay of Fundy) have been lost during the last 300 yr (Environment Canada Lands Directorate 1986; Government of Canada 1991; National Wetlands Working Group 1988). Musquash marsh is classified as a Class I salt marsh (Roberts 1993). Class I marshes are large, with a known or assumed high value to wildlife, and represent the highest priority for protection and management. When all factors are considered, there are few pristine salt marshes remaining in NB, so remaining marshes should receive high priority for preservation (Roberts 1993). This area has been described by the Conservation Council of New Brunswick (CCNB) as one of the last ecologically intact estuaries in the Bay of Fundy (Harvey et al. 1998; Platt 1998). As such, its inclusion in an overall Bay of Fundy Integrated Coastal Zone Management (ICZM) plan is essential. The ecosystem health of this estuary and its surrounding marshes affects the immediate area within its water circulation influence (Fred Page, DFO, Biological Station, 531 Brandy Cove Road, St, Andrews, NB E5B 2L9, pers. commun.). A much wider scope of influence is the provision of larval fish habitat for Bay of Fundy commercial species and the associated food chain, and the high export rate of dissolved organic matter into the Bay.

1	Outer boundary – Musquash Head	-66° 14' 13"W	45° 08' 34"N
2	Outer boundary – Gooseberry Island	-66° 15' 36"W	45° 08' 12"N
3	Outer boundary – Gooseberry Cove (western end)	-66° 15' 55"W	45° 08' 26"N
4	Inner boundary – Head of tide at Hydro Station	-66° 19' 29"W	45° 11' 49"N
5	Scallop fishing limit – Black Beach (southern end)	-66° 13' 55"W	45° 09' 11"N
6	Scallop fishing limit – Robinson's Head	-66° 15' 06"W	45° 08' 46"N

AREA MORPHOLOGY

The names for the various creeks, beaches and land features in and around the Musquash Estuary are shown in Fig. 3a and 3b. The mouth of the Estuary occurs between two headlands (Musquash Head and Western Head) and is relatively deep and narrow (Fig 1). The estuary is 16.3 km long and drains the Musquash River and marsh. Roberts (1993) reported that Musquash marsh is about 395.2 ha, if it includes the minor creeks, ditches, and intertidal areas within the salt marsh. Thompson (2000), however, estimates that Musquash Estuary contains approximately 773 ha of marshland and of this 141.5 ha are currently dyked to create freshwater ponds and marsh habitat for ducks (see Ducks Unlimited Impoundments, Fig. 1). The freshwater flow into the estuary is regulated by discharge through turbines from a small electric generating plant (Kristmanson 1974) and from several small creeks (Fig. 3a, 3b). Intertidal transect profiles by MacKay (1975) (Fig. 4) demonstrate some of the different morphology found along the estuary. Hunter and Associates (1982) described the morphology and general geology of the area. It is comprised of a large estuarine embayment with a relatively narrow entrance between rocky exposed headlands. Beaches and intertidal mud/sand flats are found in the harbour, turning to mud in the protected embayments (Fig. 5). The wave-exposed headlands are composed of purplish-red sandstones with minor conglomerates and shales. The cliffs of Western and Musquash Heads and off Gooseberry and Split Rock contain gray-green mafic and felsic volcanic flows, and are carbonaceous south of Black Beach. Black Beach is very coarse and contains a high percentage of cobbles. Within Musquash Harbour, crystalline limestone and dolomite with quartzite and quartzitic argillite outcrops form the cliffs. Further in, the bedrock is mantled with a shallow veneer of glacial drift. The intertidal area of the headlands consists of vertical rock faces eventually giving way to more gradual inclines in the upper harbour (McEachreon 1985) (Fig. 4). Beyond Black Beach, while there is a predominance of rocky shorelines, more boulder and sandy beaches are encountered. The bedrock in these areas, however, does not extend all the way to the low water mark because of the presence of sediment pockets (McEachreon 1985). Above Musquash Island, the river channel narrows and mudflats predominate at levels below mean tidal height. The river above Five Fathom Hole is bounded by tracts of salt marsh with few rock outcrops. The substrate of Hepburn Basin (Fig. 1) ranges from an extensive salt marsh dominated by marsh grasses, a sand and gravel beach with occasional peat banks and a gradation of cobble to bedrock near the mouth of the Basin (Gratto 1986).

OCEANOGRAPHY

Musquash is a strongly tidal estuarine system. Kristmanson (1974) described the Musquash system as consisting of a 10 km long river which flows into a shallow harbour (6 by 3 km). Its outer headlands are exposed to significant wave action. Aerial photographs off Coleson Cove show rip eddies generated in response to tidal currents. Turbid nearshore waters occur on both the flood and ebb tide, and the harbour itself has high turbidity as a result of resuspension of bottom sediments. Sediment is exchanged with offshore water masses as well as being transported further inshore (Hunter and Associates 1982). The freshwater flow in the river is controlled by the Musquash River Hydroelectric Development.

The Musquash Estuary experiences a tidal amplitude of about 6 m (Gratto 1986). Kristmanson (1974) recorded soundings of 1.2 m (4 ft) at low water (LW) at the head of the estuary (12.8 km from the mouth of the harbour). Wildish (1977) recorded water depths at low tide ranging from 1-6 m at mid channel stations in the estuary (Fig. 6). Kristmanson (1974) estimated the saltwater volume discharge of the harbour over a tidal cycle (from Five Fathom Hole out) to be 2100×10^6 cu. ft, with a freshwater discharge of only 9×10^6 cu. ft for the same period. The total amount of water to pass the wharf on one tide is over 30 times the freshwater input. Salinities recorded by Kristmanson at 1-m depth at low and high water are shown in Fig. 7a and 7b. The river is well mixed at high water (HW), and differs only slightly in salinity from the rest of the Bay of Fundy. In the river, salinities vary from 0-30 ppt. In the harbour at HW, salinities exceed 28 ppt. At very LW, salinities vary from 17 ppt at Five Fathom Hole, to 28.7 ppt beyond Musquash Head. In August, the salinity levels are approximately 5 ppt higher than in May. From a biological perspective, salinities below 25 ppt are of particular interest, as saltwater species distribution then becomes limited. Kristmanson (1974) further speculated that the movement of a hypothetical pulse of freshwater released at HW from the Hydro Station would take 6 d to reach Five Fathom Hole. The dispersion mechanisms would, by then, have spread and diluted the pulse considerably, and its effect would be felt in the harbour and in the river. Salinity levels in the harbour proper depend on a balance between the freshwater input and the exchange of the estuary with the waters of Bay of Fundy.

In order to validate Kristmanson's (1974) findings, and to obtain a baseline description of the oceanography for Musquash Harbour, Dowd et al. (unpublished) collected data from 21 stations in September 1999 (Fig. 2a). The innermost station was located at the Highway #1 Bridge while the outer stations were located in deeper waters beyond the mouth of the estuary. Vertical profiles of oceanographic variables (salinity, temperature, chlorophyll, water density, oxygen and turbidity) were collected at each of the 21 stations. These stations comprised a section running from the mouth to the head of the Musquash Estuary. From these profiles, plots were done to show surface and bottom salinity (ppt) (Fig. 8a, 8b), temperature (°C) (Fig. 8c, 8d), oxygen (mg /L) (Fig. 8e, 8f), chlorophyll (fluoresence units) (Fig. 8g, 8h), turbidity (Formazin turbidity units) (Fig. 8I, 8j), and water density (σ_t in kg/m^3) (Fig. 8k, 8l). Section plots of some of this information, from the mouth of the estuary (station 7, Fig. 2a) up to Highway #1 Bridge (station 18, Fig. 2a), are shown in Fig. 8m. They have been plotted based on the straight-line distance between the stations (Fig. 8m). All measurements were taken on the same day in a relatively short time period to avoid tidal aliasing.

The water is generally well mixed in the vertical, especially landwards of Five Fathom Hole. At Five Fathom Hole, vertical stratification is present and this point marks the divide between the oceanic and river/estuarine regimes. The section plots show a strong along-axis gradient in some of the water properties. The salinity varies from freshwater recorded at the Highway #1 Bridge to oceanic Bay of Fundy water at the mouth of the estuary. The highest temperature (17.1°C, surface) occurred at the Highway #1 Bridge and there was a gradual decrease towards the mouth of the estuary to a low of 12.6°C (bottom). Temperature rises over 4-5 degrees going inland. Density of the water (the dynamic quantity that sets up pressure differences and drives mean circulation) is set by the salinity variations. Turbidity was recorded as being high in the inner part of the estuary and lower in the area around the mouth. Turbidity rises by 2 orders of magnitude going inland. Surface oxygen concentrations varied less, being generally higher at the head than the mouth. Similarly, chlorophyll concentrations were higher in the upper reaches of the estuary and lower around the mouth.

Other preliminary observational studies have been undertaken in order to characterize the oceanography of Musquash. A temperature and pressure (tidal height) sensor was deployed near Five Fathom Hole Wharf in December 1999. The intention is to provide a continuous high frequency time series record of these variables over the seasonal cycle and beyond. This is part of the overall effort to design and establish long-term monitoring stations at specific locations in the estuary in order to look at seasonal and inter-annual fluctuations in primary physical and biological oceanographic variables (e.g. temperature, salinity and turbidity, as well as nutrients and plankton). This will be supplemented with more intensive observational studies designed to determine high frequency variability and spatial differences in the oceanography throughout the system. We envisage that this will be achieved by observations from moored instruments, from transect data, and from drifter deployments in key locations to determine circulation patterns. More detailed analyses and modelling work might later be undertaken in order to address scientific and management questions.

In addition to a description of the oceanography within the Musquash system, it is also important to address remote effects on the system, such as how the harbour is influenced by adjacent regions. For example, in terms of the transport pathways for materials, the St. John River plume may have an important influence on the Musquash system. Neu (1960) reported on a hydrographic survey of Saint John Harbour, which includes calculations of the river discharge, locations of dredging and current directions at the mouth of the harbour. This report will be useful in determining the influence of the St. John River on the oceanography of Musquash. In general, more observational and modelling work will be needed to get estimates of the circulation or flushing within different regions of the Bay, as well as the overall exchange with the Bay of Fundy. This is the type of information that needs to be updated and validated from Kristmanson's (1974) work. From either a management perspective, or as custodians of marine ecosystems, this sort of information is needed in order to assess any potential risks from pollutants, increased siltation or catastrophes (oil spills), and to understand the nature and functioning of the ecosystem.

WATER QUALITY - NUTRIENTS AND CONTAMINANTS

In order to maintain environmental quality by restricting/prohibiting developments within the estuary, it will be important to consider that nutrients and contaminants enter through exchange with waters from the Bay. Hunter and Associates (1982) reported the following possible sources of contamination:

Coleson Cove oil-fired thermal generating station, significant air pollution with frequent ground level fumigation as well as long range transport of airborne pollutants, release of heated and often contaminated cooling water, and minor oil spills and leaks. MacKay (1975) sampled for contaminants in the water during August and October 1974 in Musquash Estuary and along the coast towards Lorneville Harbour (Fig. 9a). The data obtained indicated that high concentrations of lead (Fig. 9b) and mercury (Fig. 9c) occurred just outside of the harbour. Locations of high copper and phosphate concentrations are shown in Fig. 9d and 9e. It appears that some of these contaminants may be carried into Musquash Harbour by water currents. Transparency was measured in August and October 1974 (MacKay 1975) (Fig. 9f), and turbidity in September 1999 (Dowd et al. 1999) (Figs. 8i and 8j).

Nutrient studies define remote vs. local effects. For Musquash, the potential is higher for contaminant loadings from offshore activities in the Bay of Fundy to be the major control mechanism of water quality in the estuary, regardless of efforts to control development within the estuary. Samples for silicate, phosphate, nitrate, nitrite, and ammonia will be collected in the summer of 2000. Sampling will be done along a few stations to assist in deciding where to resample at a later date. A routine monitoring station at Musquash will include the sampling of nutrients. The identification of a good indicator species for contaminants will enable the study of levels of cadmium, copper, silver, and zinc. Other studies/monitoring underway include stream effluents being monitored by NB Department of Environment, and bacterial counts (Richard et al. 1998, Fig. 10) monitored by Eastern Charlotte Waterways Inc. (ACAP).

PLANKTON AND FISH LARVAE

Plankton studies include information on predominant phytoplankton species present in the estuary. Additionally, zooplankton, fish eggs and larvae present will add to the potential significance of this area. For a preliminary assessment, three samples for plankton were collected from the Musquash Estuary on June 26, 1999 (Fig. 2a). One sample (taken at the inner most location in the Estuary) had a very high percentage of detritus. Martin and LeGresley (unpublished) analyzed the samples for phytoplankton only. There were 29 different species identified in the plankton (Appendix 1). Results show a variety of species present, all of which commonly occur in the Bay of Fundy. This sampling, however, represents only a single window of information. Compared to monitoring stations at Lime Kiln Bay and Brandy Cove (June 21 and 29, 1999; Martin and LeGresley, unpublished), data from the Musquash samples have approximately the same number (and type) of species but fewer cells.

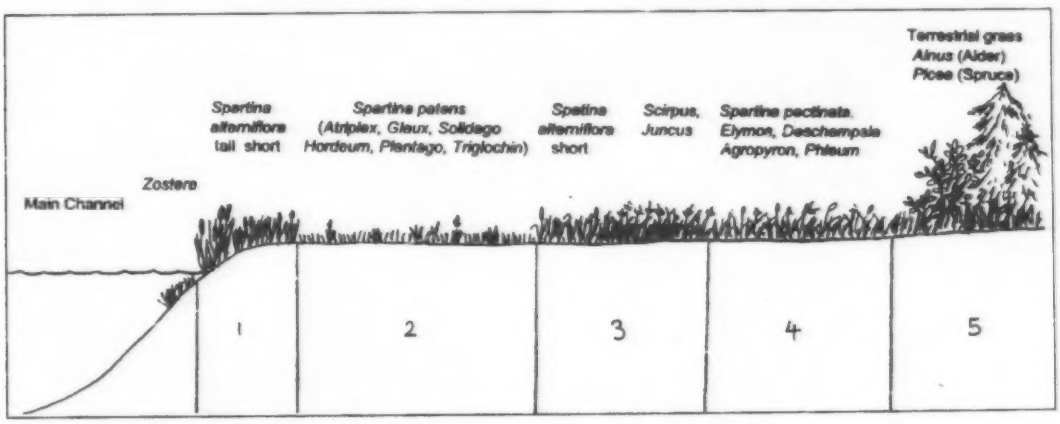
- *Alexandrium fundyense*, the dinoflagellate responsible for PSP (paralytic shellfish poisoning) which is found in the Bay of Fundy generally during summer months is responsible for the closures of shellfish harvesting areas on an annual basis. The highest number of *A. fundyense* cells observed was 340 cells·L^{-1}.
- The diatom *Pseudo-nitzschia pseudodelicatissima* produces domoic acid and results in amnesic shellfish poisoning (ASP). This diatom is very minute and requires approximately 1,000,000 cells L^{-1} before domoic acid can be detected. Only 80 and 40 cells·L^{-1}, respectively, were detected in two of the samples.
- *Dinophysis* spp. and *Prorocentrum* spp. were also observed. These are known to produce diaarhetic shellfish poisoning (DSP) elsewhere in the world but have never been linked in the Bay of Fundy with any problems.
- Also found were the following species which are non-toxic to humans, but potentially harmful to fish and invertebrates: *Cerataulina pelagica*, *Chaetoceros* spp., *Chaetoceros socialis*, *Ceratium fusus*, *Dictyocha speculum* and *Mesodinium rubrum*. *M. rubrum* caused the red tide in Passamaquoddy Bay in 1998-99 and resulted in farmed salmon mortalities.
- Other species found were basically harmless species but under exceptional conditions can bloom so densely that they discolour the water. The bloom decay may cause oxygen to become depleted. These include *Skeletonema costatum* and *Leptocylindrus minimus*.

Monitoring of phytoplankton, as well as zooplankton, could be accomplished on the same basis as other hydrographic, nutrient, and plankton samples taken routinely in the Bay of Fundy. Only 1-3 stations are necessary to monitor the area effectively. Sampling should be more frequent than monthly for phytoplankton monitoring during May-September.

MARSH ECOLOGY

Generally in Fundy marshes, plant communities consist of the genera *Spartina*, *Puccinellia*, *Distichlis*, as well as rushes and reeds (*Juncus*, *Scirpus*), with other scattered perennials (*Armeria*, *Plantago*,

Triglochin, Limonium, Cotula, Selliera) (Thomas 1983). Characteristic annuals include *Salicornia, Suaeda* and *Atriplex*. Hinds (1999) identified other salt marsh species such as *Eleocharis halophila, Carex mackenziei, Hierochloa odorata, Ranunculus cymbalaria* and *Galium trifidum*. Algae present include *Fucus, Bostrychia, Ulva, Enteromorpha, Ulothrix, Cladophora, Microcoleus* and *Alderia modesta*. Musquash is dominated by *Spartina alterniflora*, especially where the bank is not significantly above the landward marsh. Species found most frequently where the banks are raised include *Spartina patens, Triglochin maritima, Plantago maritima, Atriplex padula, Suaeda maritima, Limonium nashii* and *Salicornia europaea*. In places showing erosion or damage to the bank, stands of *Salicornia* may be found. The following sketch of South Musquash salt marsh zonation shows the distribution of the common plant species (Stevens 1997). Note the typical low inclination of the marsh flat in this area.



Marine resident fauna (Appendix 1) in the marshes include *Macoma balthica, Nereis diversicolor,* and *Mytilus edulis* in the lowest zones of *Spartina alterniflora* (Thomas 1983). A tiny snail, *Hydrobia minuta*, and the mummichog *Fundulus heteroclitus* are often abundant, and *Littorina saxatilis* (rough periwinkle) is the most generally distributed marine form. The green crab *Carcinus maenas* is occasionally found along the creeks. The isopod *Idotea phosphorea*, the amphipod *Corophium volutator,* and the saccoglossan *Alderia modesta* occur in tidepools and creeks. Gammarids can be found among the vegetation. Wildish (1977, 1983) divided the species found in Musquash into three groups based on dominance: a *Mya, Corophium, Nereis* association; a *Nepthys ciliata, Balanus, Nereis* association; and a *Sternapsis, Clymnella, Nepthys incisa* association. Wildish found a total of 36 different faunal species among 12 stations studied (Fig. 11a).

Production (amount of detritus carbon produced for system energy) in eastern North American marshes is mostly derived from *Spartina alterniflora*. In Musquash, Wildish (1977) estimated a range of 0.1-1.7% dry weight of organic carbon present. The percentage of net production exported in the form of detritus (dead vegetation - *Spartina*), on a receding tide represents the food energy source to the coastal ecosystems, and is significant in the Bay of Fundy. Data on sorting coefficients (settling of different-sized particles) for Musquash Estuary indicated that at some locations there was net deposition (Wildish 1977) (Fig. 11b). There was a linear relationship between QDΦ values (sorting coefficients) and the measure of organic carbon (Fig. 11b, 11c, 11d). Some stations showed that tidal currents do not differentially erode organic particulate matter; that is, net depositional sedimentation occurs. Whether an area undergoes net sediment erosion or deposition strongly influences the type of macrofauna community found there. For example, high tidal energy limits diversity, and there is a corresponding low sediment carbon level. Many of the stations in Musquash border on being of high tidal energy. These conditions are present in stations 6 and 9 (Fig. 2), and are correlated to low diversity and low sediment carbon levels. Low salinity can also be a limiting factor and decreases the diversity of marine species (with a corresponding increase in freshwater species). The trophic ratio for Musquash at station 6 (Fig. 2b) is 100% deposit feeders, and in stations 1 and 2 there is marked impoverishment due to low salinity (Fig. 11a, 11d).

INTERTIDAL AND BENTHIC ECOLOGY

	Terrestrial: Trees, grasses and other flowering plants
Sub-maritime fringe	Edge of turf: Few flowering plants below this point
	Upper limit of lichens: *Verrucaria, Xanthoria, Caloplaca, Parmelia*
Supralittoral Zone	Upper limit of *Littorina*
Supralittoral fringe	Upper limit of Barnacles; Narrow band of *Fucus spiralis*
Midlittoral Zone	Under *A. nodosum* canopy: *Sertularia, Flustrellidra, Fabricia.* May be present: *Arcophoina arcta, Mastocarpus stellata, Chondrus crispus, Palmaria, Colissella (Acmaea)*
	Upper limit of *Ascophyllum*; Present: *A. arcta, M. stellata, C. crispus*
Infralittoral fringe	Lowest low water; *Strongylocentrotus, Alaria, Laminaria*
Subtidal Zone	

Thomas (1994) has described the general characteristics of the rocky intertidal zone at Musquash Head. The sketch above shows the typical zonation of species on the rocky intertidal zone. The very top of the shore (**supralittoral zone**) is always dominated by the lichen *Verrucaria maura*, and is therefore black in colour. Where *Xanthoria parietina* and *Caloplaca marina* are abundant, the area may be brilliant orange, but more usually it is bare rock with patches of gray *Parmeila* sp. A few flowering plants are scattered through the zone, the most common being *Plantago oliganthos* and *Deschampsia flexuosa*. *Littorina saxatilis*, the determinative organism in the **supralittoral fringe**, ranges from rare to very common. The bottom of the fringe is normally marked by a narrow band of *Fucus spiralis*. The mid intertidal (**midlittoral zone**) is completely dominated, except at the very bottom, by *Ascophyllum nodosum*. Occasionally, patches of *Fucus vesiculosus* appear. *Hildenbrandia rubra* and *V. mucosa* are important crustose species at all locations and levels. The three littorinids, *L. saxatilis*, *L. obtusata*, and *L. littorea* appear in sequence with decreasing level and are usually abundant. Under the *A. nodosum* canopy, *Sertularia pumilla, Flustrellidra hispida* and *Fabricia sabella* are ubiquitous. Red algae, such as *Mastocarpus stellatus* and *Chondrus crispus*, usually appear in the mid-midlittoral and increase downward along with the limpet *Colissella (Acmaea) testudinalis*. At the base of the midlittoral zone are found one of *Acrosphonia arcta, M. stellatus, C. crispus*, or *Plamaria palmata*. The lower end of the shore (**infralittoral fringe**) is grazed by the urchin *Strongylocentrotus droebachiensis* and is often mostly bare rock. The kelp, *Alaria esculenta* is frequent, and *Laminaria* sp. are rare, although both are found in extreme exposure areas, where urchins are less common. Where grazing is moderate, a mixture of *A. arcta, M. stellatus, C. crispus, P. palmata* and *Halosaccion ramentaceum* is the normal canopy, with crustose corraline algae beneath.

Thomas and Page (1983) studied the effect of grazing by the gastropod, *Lacuna vincta* in the lower intertidal at Musquash Head. They reported that there was a sudden appearance during June-August 1981 of large numbers (reaching up to 280 m^{-2}) of this herbivore, principally on the *Fucus edentatus* in the lower intertidal. This sudden appearance was due to migration from the subtidal zone, and grazing resulted in the removal of 79% of the net production of *Fucus edantatus* in the monitored areas (Thomas and Page 1983). Thomas (1994) conducted three parallel intertidal transects at Musquash Head and recorded as many as 103 species. The largest group was the algae with 36 species, while 25 species of fauna were recorded. Other groups identified included lichens, bryophytes and angiosperms (Thomas 1994).

Benthic plants and animals live on the sea bottom. Their presence or absence is dictated by many physical parameters. The type of substrate (mud, rock, sand), however, plus water exchange/current, are critical. An animal attached to a hard substrate, such as a rock, can in itself provide a habitat to another smaller species (such as a large sponge harbouring amphipods and crabs). The study

of benthic communities can be accomplished at various levels/scales, and can include intertidal and subtidal sampling transects, video transects and soft sediments. Wildish (1977, 1983) did a series of grabs along Musquash and estimated numbers and biomass of a large number of macro-infauna (Fig. 11d and 11e).

Based on direct observations and on the present fishing patterns, the Community Coastal Resource Mapping (CCRM 1999) project identified areas in the Musquash Estuary that were deemed to have high densities of species of commercial importance. The species identified include rock crab (Fig. 12a), lobster (Fig. 12b), soft-shell clam, herring, and scallop (Fig. 12c). During the fall lobster fishing season twelve vessels fish traps at Gooseberry Island, Musquash Head and across the mouth of the estuary (Thompson, 2000). According to Thompson (2000), scallop dragging, by four to six vessels, is usually carried out inside the mouth of the estuary when weather conditions do not permit the boats to go elsewhere. The CCRM (1999) project also identified areas with high rockweed, periwinkle, and sea urchin densities (Fig. 12d). Periwinkle harvesting areas and clam beds were further mapped by Thompson (2000) (Fig. 12e). Periwinkles, clams, and dulse are harvested within the estuary for commercial and recreational purposes. The amounts harvested, however, are small and commercial harvesting only occurs on an irregular basis (Thompson, 2000). Two seal haul-out sites were identified in the Musquash Estuary: Musquash Island and Musquash Head (Fig. 12c) (CCRM 1999).

Gratto (1986) reported some 35 benthic species from the intertidal mudflats in the Hepburn Basin area of the Estuary (Fig. 1). The dominant species were the amphipods, *Corophium volutator* (up to 30,000 m^{-2} in late summer) and *Gammarus lawrencianus* (up to 14,000 m^{-2}). Other species collected in epibenthic sampling included the mysids, *Neomysis americana*, *Mysis stenolepsis*, and the carid shrimp, *Crangon septemspinosa*. Based on diets, Gratto (1986) divided the 21 species of fishes caught into three groups. The planktivores fed mainly on harpacticoid and calanoid copepods and included the Culpeoids (herring, gaspereau) and *Menidia menidia* (silverside) with very young Gadoids (cod, pollock). The larger Gadoids, in addition to *Osmerus mordax* (smelt) and large *Microgadus tomcod* (tomcod), fed on benthic crustaceans primarily amphipods and the carid shrimp. The three species of flounders (winter, yellowtail and smooth flounders) fed mainly on benthic polychaetes. Gratto (1986) estimated that 8 species of shorebirds (sandpipers, plovers, grabs. Grabs deployed from a boat are best for sampling the animals living below, within, or partly buried (sublittoral macro-infauna) in yellowlegs, willet, and dowitcher) consumed 6-11% of the annual *Corophium* production during the fall migration (mid-July to October).

Direct surveyance (SCUBA), video transects (direct or remote), and photographic materials are low impact, efficient ways of assessing underwater communities (sublittoral benthic communities), assuming conditions are amenable. MacKay (1975) studied the Lorneville and Musquash benthos using direct observations intertidally, and SCUBA subtidally. Nine intertidal transects (Fig. 2a and 4) were performed in Musquash Estuary by MacKay (1975). Species identified along the transects were assessed on an abundance criteria (present, common, abundant). The largest number (29) of species (both flora and fauna) was recorded in south side of Wallace Cove (Fig. 13). The Wallace Cove area also had the highest number of plant species. Table 1 shows the number of species in the different trophic groups observed along each transect by MacKay (1975).

Data from studies by Wildish (1977, 1983) and MacKay (1975) (presence-absence of species) will be essential in the development of a management plan. Future study plans by DFO include GIS referenced distribution maps of the major species. Preliminary planning work for this was accomplished by DFO in the summer of 1999. Visibility underwater anywhere other than at, or very near to, the mouth of the Musquash estuary was near zero. Even then, water clarity was found to be poor at the end of June and nil by the end of September. Photographs taken in turbid water conditions at Musquash Head and Gooseberry Cove are of poor quality; however, they do portray a variety of the common macro-invertebrates. Video footage, along a transect line, proved even more demanding and risky, and had to be abandoned. Our methods, the addition of lights, and time of operation (for water clarity) will be reevaluated for the next field season. It is, however, essential that the habitat mapping and the species inventory (Appendix 1) be further enhanced, as well as monitored for changes.

BIRDS

Deichmann (1999) has reported historical and recent (Spring-Fall 1999) bird observations at various locations around the estuary (Fig. 2b). He listed some 290 species of birds (Appendix 1) observed in the Musquash Estuary. Many of these birds are rare or

Table 1: Number of species in different trophic groups observed along transects by MacKay (1975). For locations of transects see Fig. 2a and 4.

Transect	Plants	Animals	Omnivore	Carnivore	Deposit-feeders	Suspension-feeders	Algal scrapers
CT1	3	6	1	0	0	3	2
CT2	2	12	1	2	2	4	2
CT3	4	9	1	1	0	4	3
CT4	7	22	1	2	8	7	4
CT5	9	15	1	2	5	6	1
CT6	8	9	1	2	1	2	3
CT7	3	8	1	2	0	3	2
CT8	1	11	1	1	3	5	1
CT9	2	12	1	1	3	6	2

very rare and many are migrant species that only visit the estuary during certain times of the year. Some 38 of these species are found throughout the area while other species occur only in certain locations. The three Ducks Unlimited Impoundments (Fig. 14a) attract a large number of ducks with some species (for example, the Pied-billed Grebe) nesting in these areas. Twelve species of waterfowl (11 species of ducks and the Canada Goose) have been confirmed as breeding in the estuary. Gooseberry Island is home to a small but significant Common Eider colony. Other locations of sightings of Common and King Eiders are shown in Fig. 14b. Some 65 species of birds were observed in the forested area along Gooseberry Cove Road while 57 species were reported in the area along Musquash Lighthouse Road (Fig. 14a). Table 2 lists the number of rare, very rare and vagrant species reported for each of the locations by Deichmann (1999). The Community Coastal Resource Mapping (CCRM 1999) project identified two of the Ducks Unlimited Impoundments as areas of importance to migratory birds (Fig. 14b). Five nesting pairs of Pileated Woodpeckers and one nesting pair of Bald Eagle were also observed during the CCRM 1999 survey (Fig. 14b).

Table 2: Number of rare, very rare and vagrant species of birds reported by Deichmann (1999) at various locations around the Estuary.

Location number	Location name	Species	Location number	Location name	Species
39(A)	DU Impoundment (East)	29	22	Bents Beach	7
40(B)	DU Impoundment (West)	27	23	Camerons Beach	7
41(C)	DU Impoundment (Menzies)	14	24	Hepburn Basin	20
1	Board Bridge Creek	9	27	Western Head	15
2	Moose Creek	9	28	Black Beach	11
4	Devebers Point	18	29	Musquash Lighthouse	19
6	Menzies Manor	14	30	Gooseberry Cove	17
7	Dunns Creek	20	31	Gooseberry Island	9
8	Negro Brook	11	32	Little Musquash Cove	7
9	Perch Brook	9	33	Butlers Cove	7
13	Five Fathom Hole	9	34	White Rocks	7
14	Butlers Creek	11	35A	East Branch Musquash R.	9
16	Connors Cove	9	35B	West Branch Musquash R.	18
17	Wallace Cove	7	36	Split Rock	9
18	Cheeseman Beach	7	37	Coleson Cove	7
19	Frenchman & Burchill Brooks	8	38	Outer Estuary Offshore	28
20	Musquash Island	8	E (forest)	Along Musquash Lighthouse Rd.	14
21	Musquash Ledges	13	F (forest)	Along Gooseberry Cove Rd.	19

TERRESTRIAL PLANTS

Hal Hinds (1999) did a recent study of the vascular plant species around the estuary. The five principal habitats examined were headlands and rocky bluffs, salt marshes, adjacent forested areas, upper beach areas, and freshwater stream sides and meadows. The species recorded are not exceptional in terms of rare species and diversity, but are typical of such estuaries in the Bay of Fundy area. The MPA boundaries will, however, include only those species within the zone defined by tidal activity below the high tide line. Hinds (1999) identified some additional species in the salt marshes including *Eleocharis halophila, Carex mackenziei, Hierochloa odorata, Ranunculus cymbalaria,* and *Galium trifidum.*

SUMMARY

The science requirements will need to be expanded or modified once underway, perhaps following the format suggested by Rangeley and Singh (2000), in a report summarizing basic monitoring requirements for an MPA. A science review, in the form of a workshop, would ensure identification of science gaps, and effectiveness and coordination of studies. The requirements for an adequate study plan need to be discussed and coordinated, and offers of assistance from the experts involved have been obtained. A workshop format might prove useful for this purpose; this could be accomplished by the formation of a Musquash Advisory Board, which would include members of the present Musquash MPA Planning Group, stakeholders, representatives of various Governments, and scientists. Consideration is being given to replicating previous studies done in Musquash to see if future change could be detected in this way. Information requirements include the assessment of nutrients and of inorganics (in sediments and organisms), hydrographic information, and species and habitat mapping. Musquash could provide the opportunity to develop the methodology and standards required to assess ecosystem health, and to detect subsequent environmental changes, both required for management of an MPA. These standards will be required in subsequent MPA sites and as a basis for sound management practices generally, so the questions answered in Musquash will be useful beyond that particular site.

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Fig. 1. Musquash Estuary: Boundaries of the MPA will include all intertidal and subtidal areas from a line between Gooseberry Island and Musquash Head, up to the head of the tide at Musquash Hydro Station. See text for the latitudes and longitudes of the numbered (1-6) boundaries.

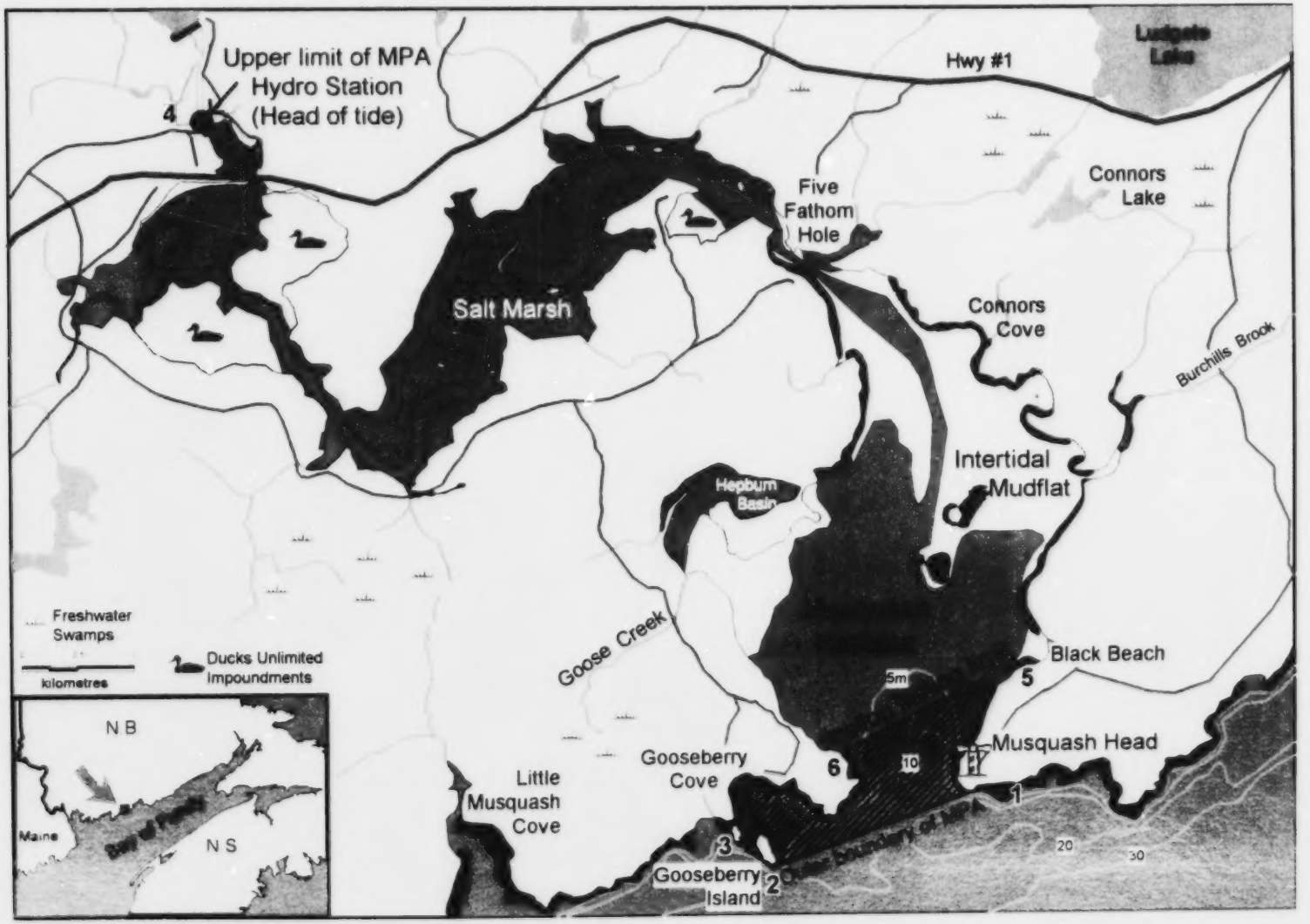


Fig. 2a Musquash Estuary: stations where studies have been done (MacKay, 1975, Dowd et al., 1999, Martin and LeGresley, unpublished)

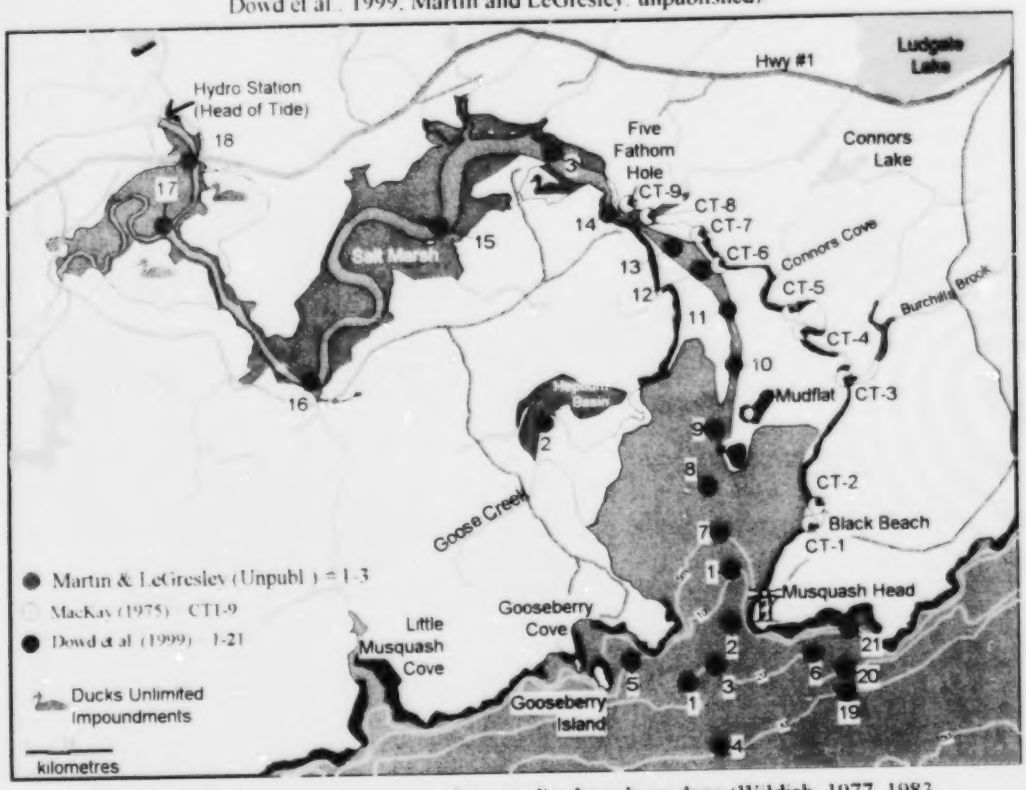


Fig. 2b Musquash Estuary: stations where studies have been done (Wildish, 1977, 1983, Deichmann, 1999)

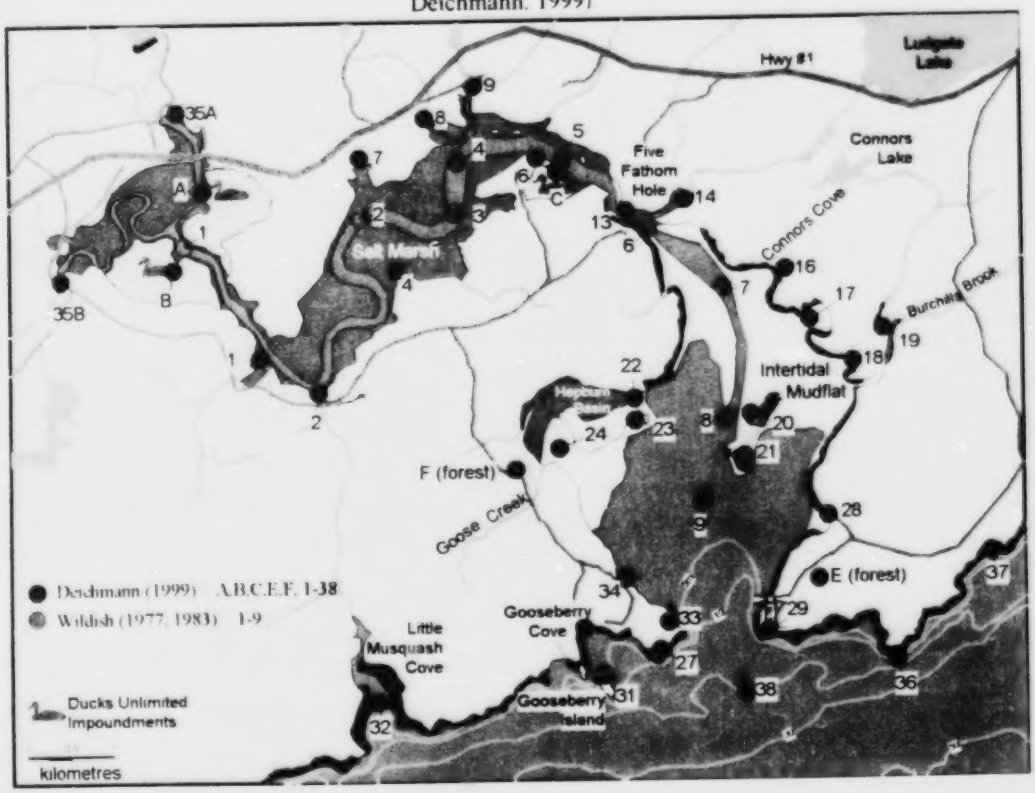


Fig 3a Musquash Estuary Names of places in and around the proposed MPA (D Thompson)

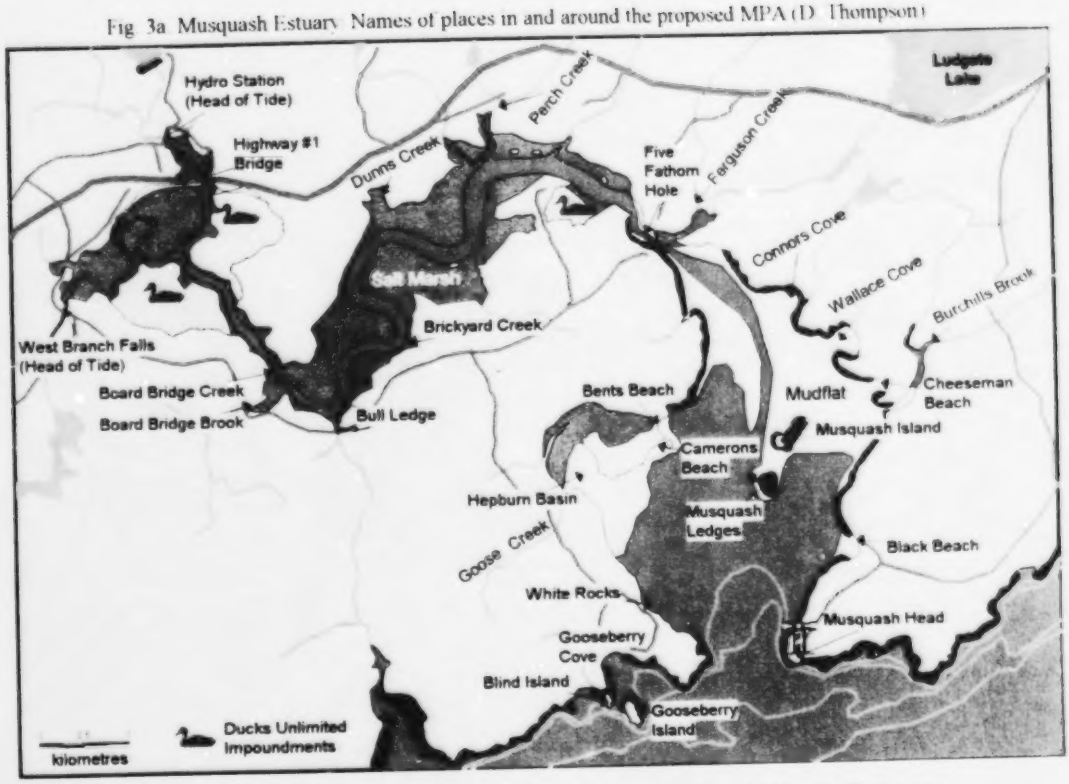


Fig 3b Musquash Estuary Names of places in and around the proposed MPA (D Thompson)

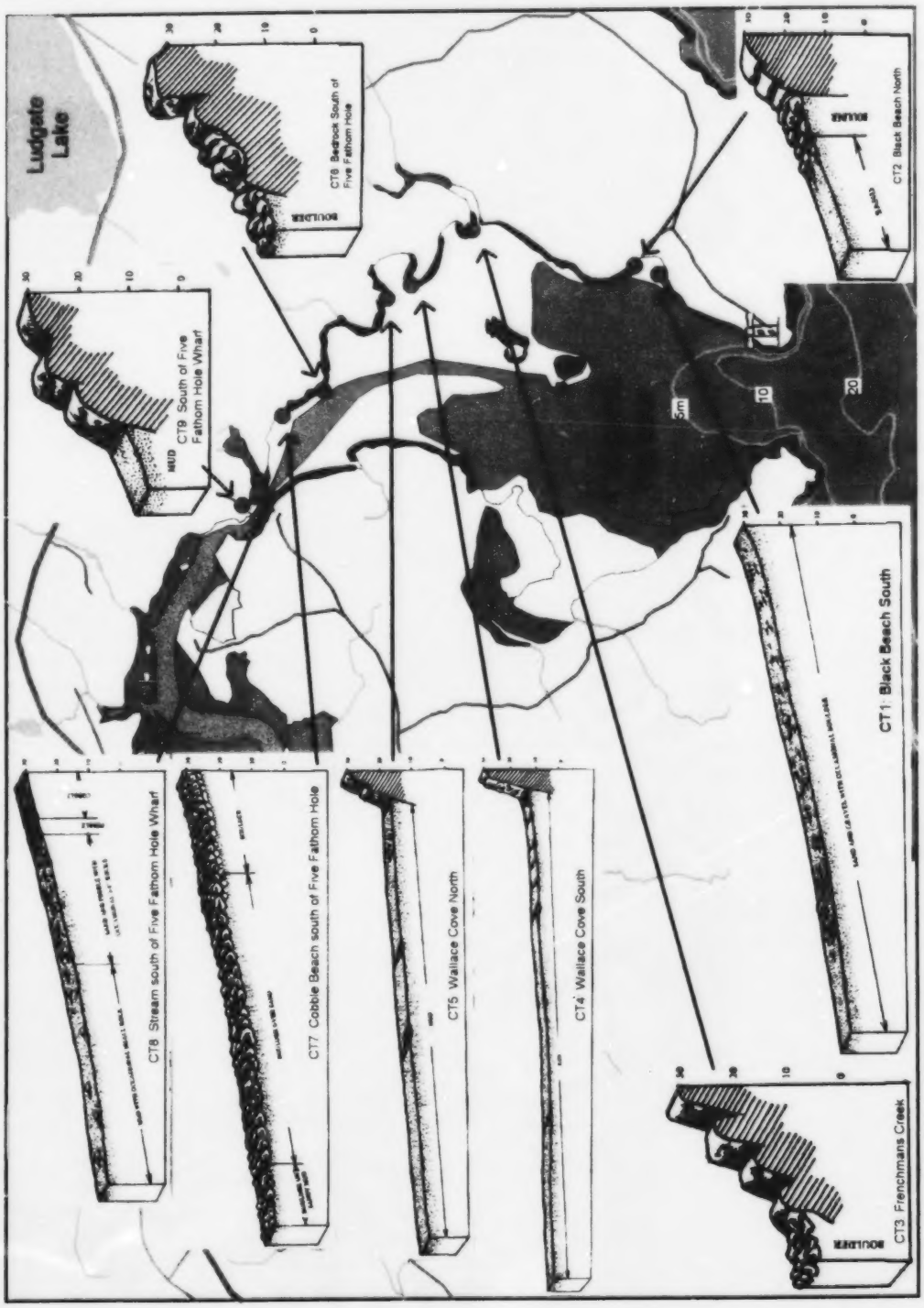


Fig. 4. Musquash Estuary: Profile of transects done in September 1974 (Mackay 1975).

Fig. 5. Musquash Harbour: Shoreline classification (CCRM, 1999).

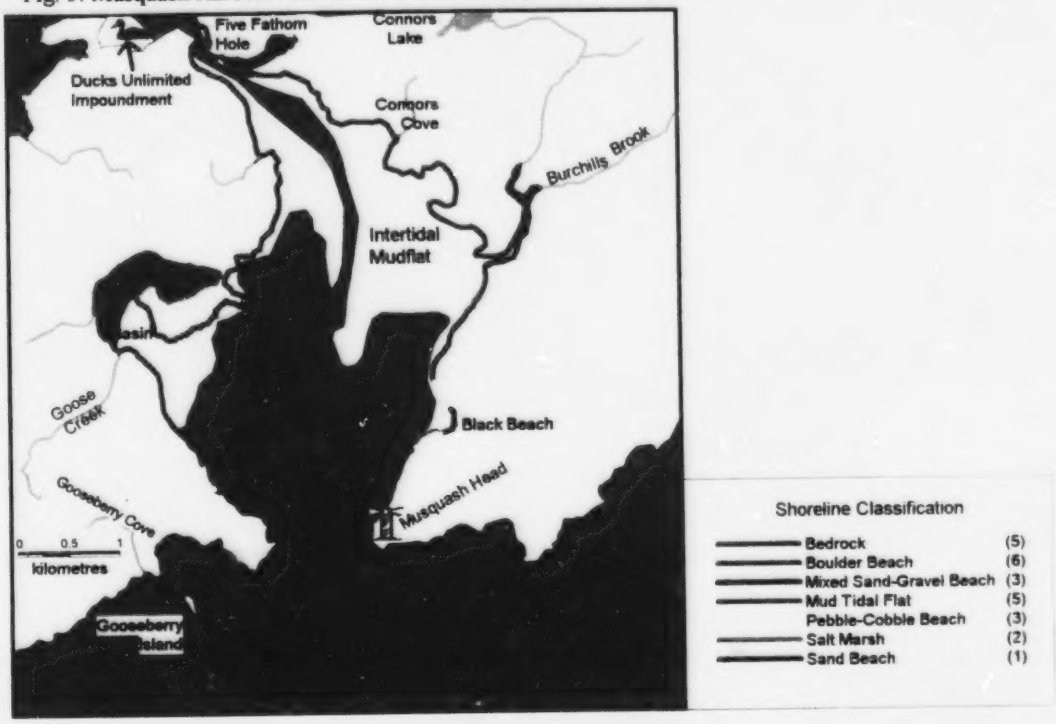


Fig. 6. Musquash Estuary: Depth (m) at Low Water for stations sampled in June 1973 (Wildish, 1977, 1983)

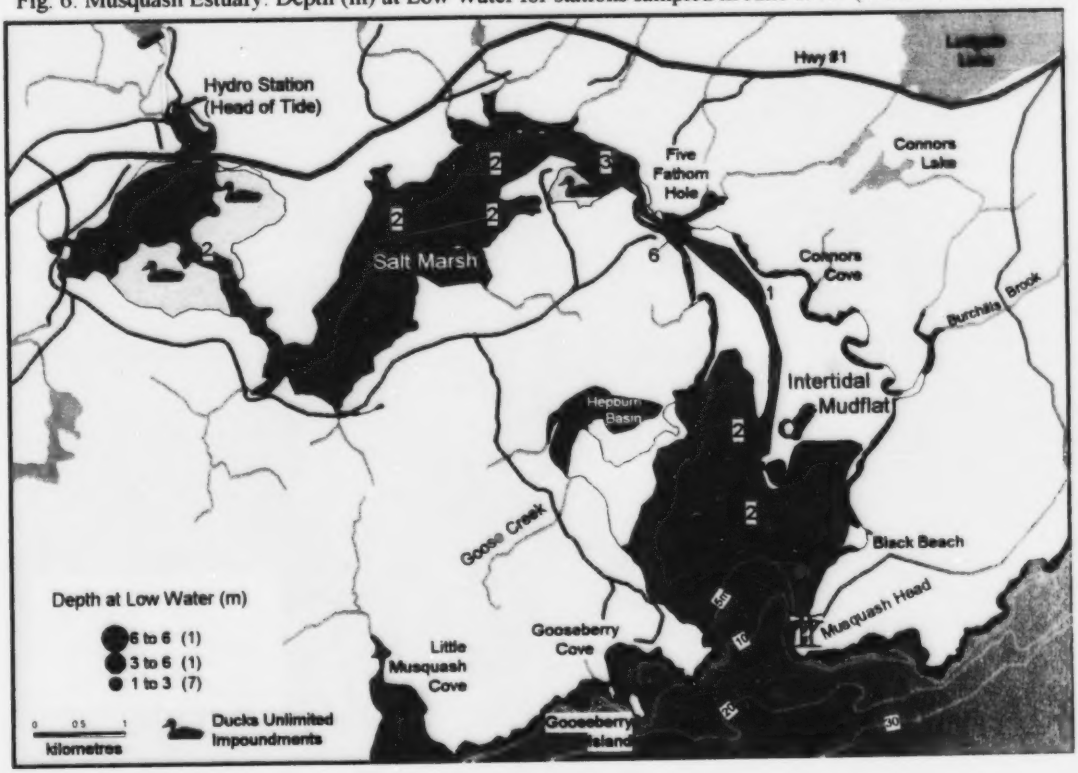


Fig. 7a. Musquash Estuary: Salinities at Low Tide on May 24, 1973 (Kristmanson, 1974).

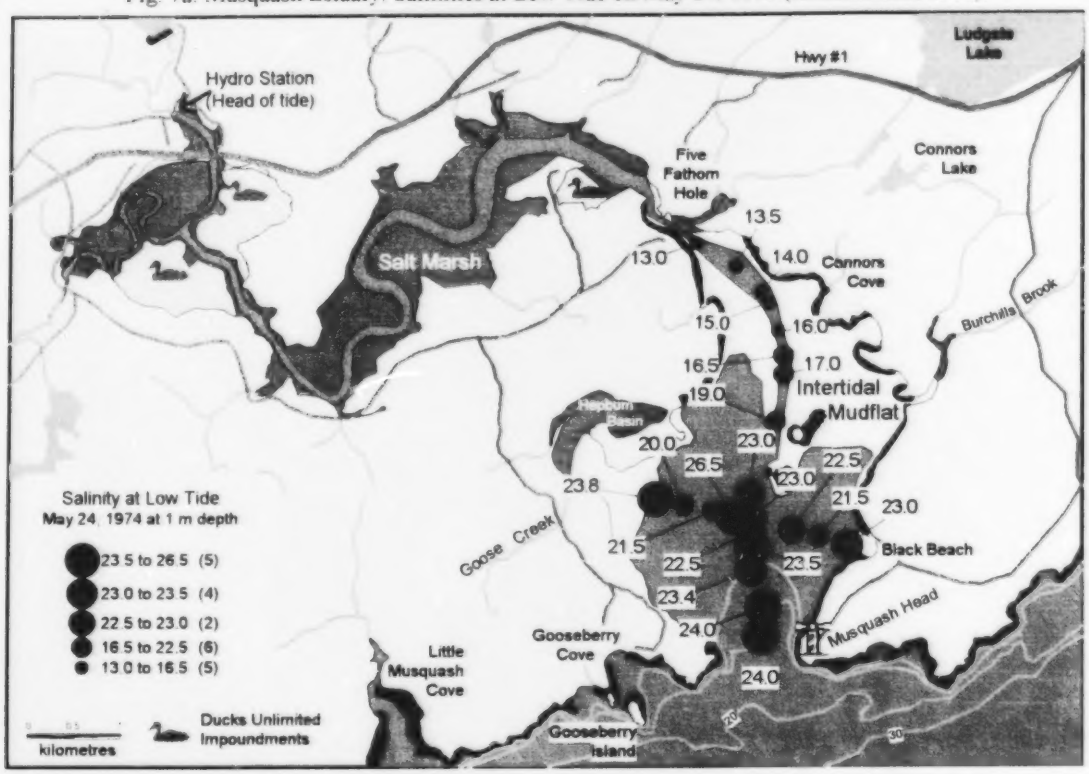


Fig. 7b. Musquash Estuary: Salinities at High Tide on May 24, 1973 (Kristmanson, 1974)

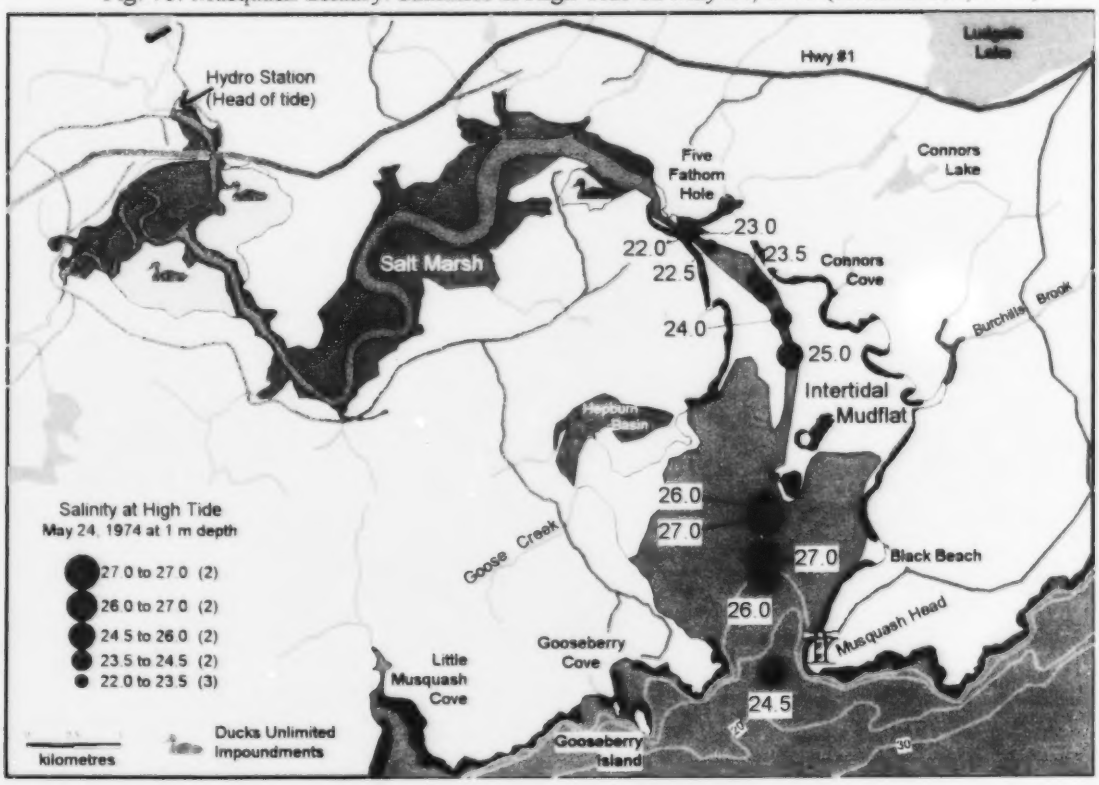


Fig. 8a. Musquash Estuary: Surface salinity - September 1999 (Dowd et al., 1999)

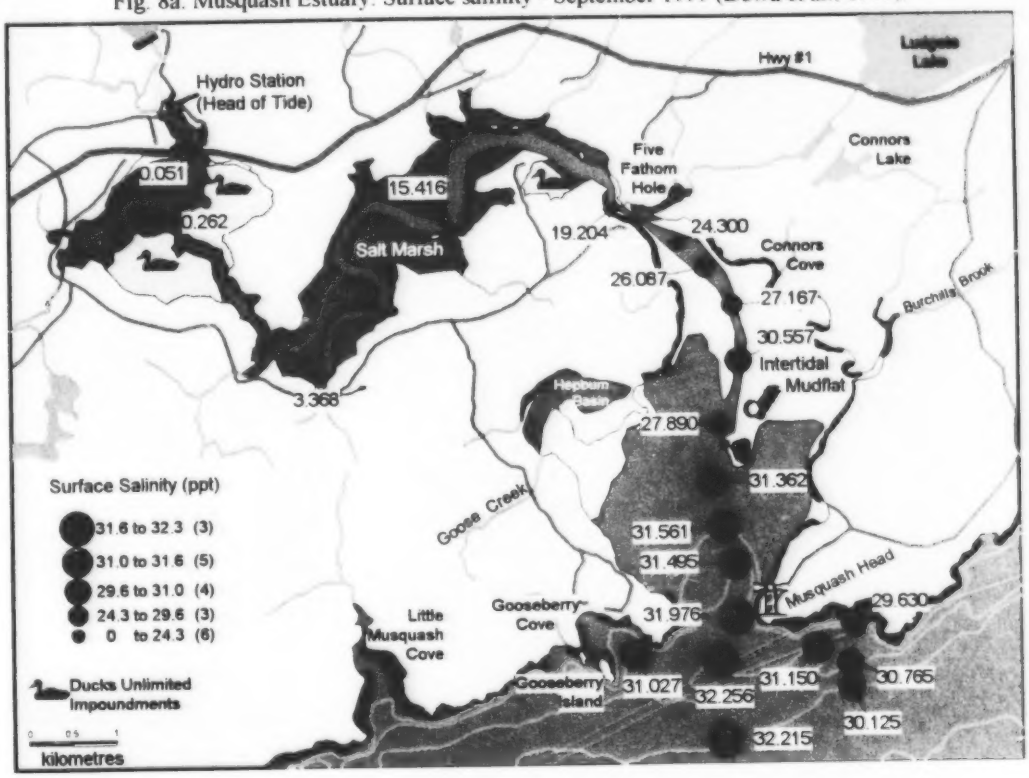


Fig. 8b. Musquash Estuary: Bottom salinity - September 1999 (Dowd et al., 1999).

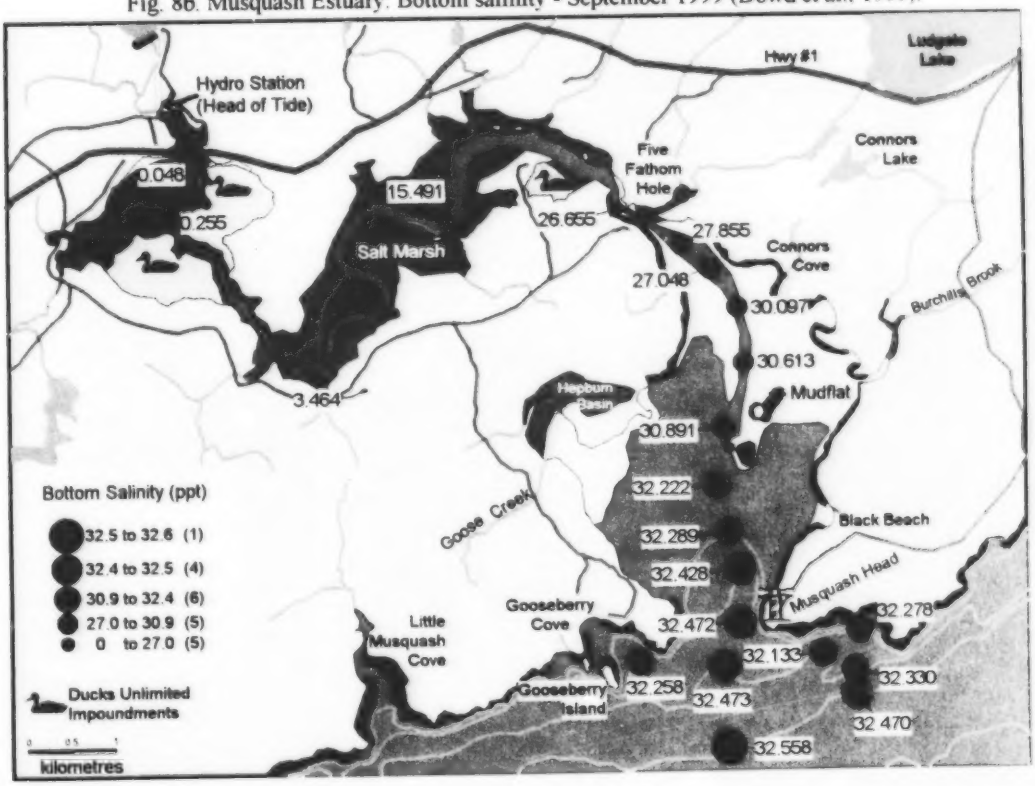


Fig. 8c. Musquash Estuary: Surface temperatures - September 1999 (Dowd et al., 1999).

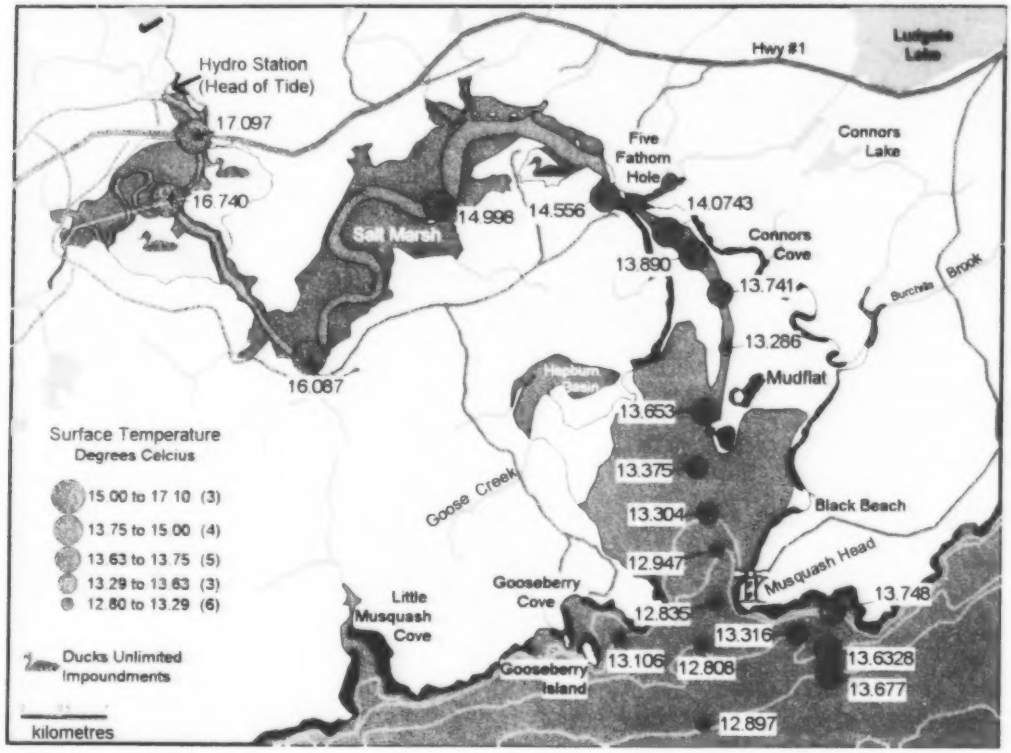


Fig. 8d. Musquash Estuary: Bottom temperatures - September 1999 (Dowd et al., 1999).

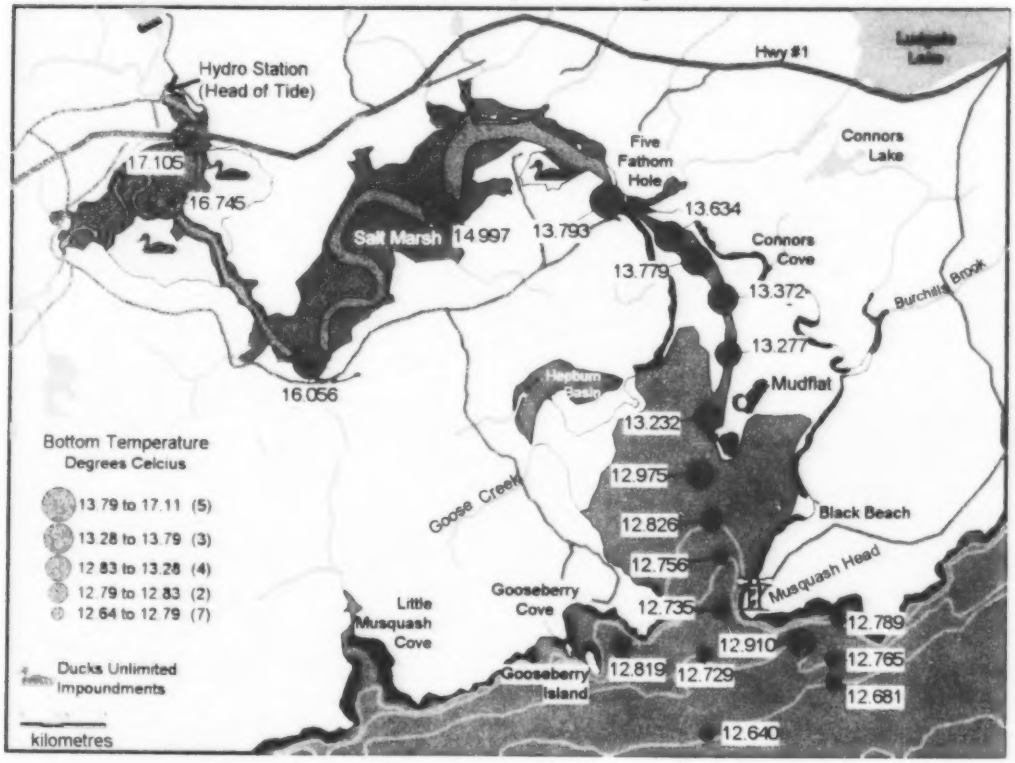


Fig. 8e. Musquash Estuary: Surface oxygen (mg/L) - September 1999 (Dowd et al., 1999)

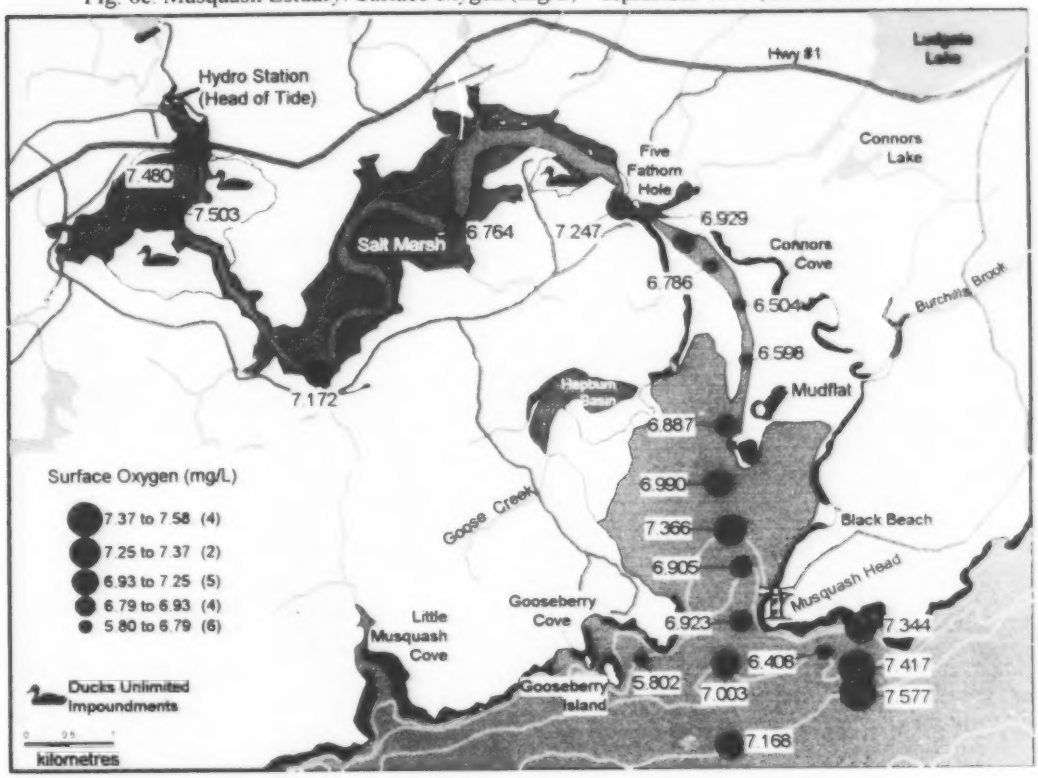


Fig. 8f. Musquash Estuary: Bottom oxygen (mg/L) - September 1999 (Dowd et al., 1999)

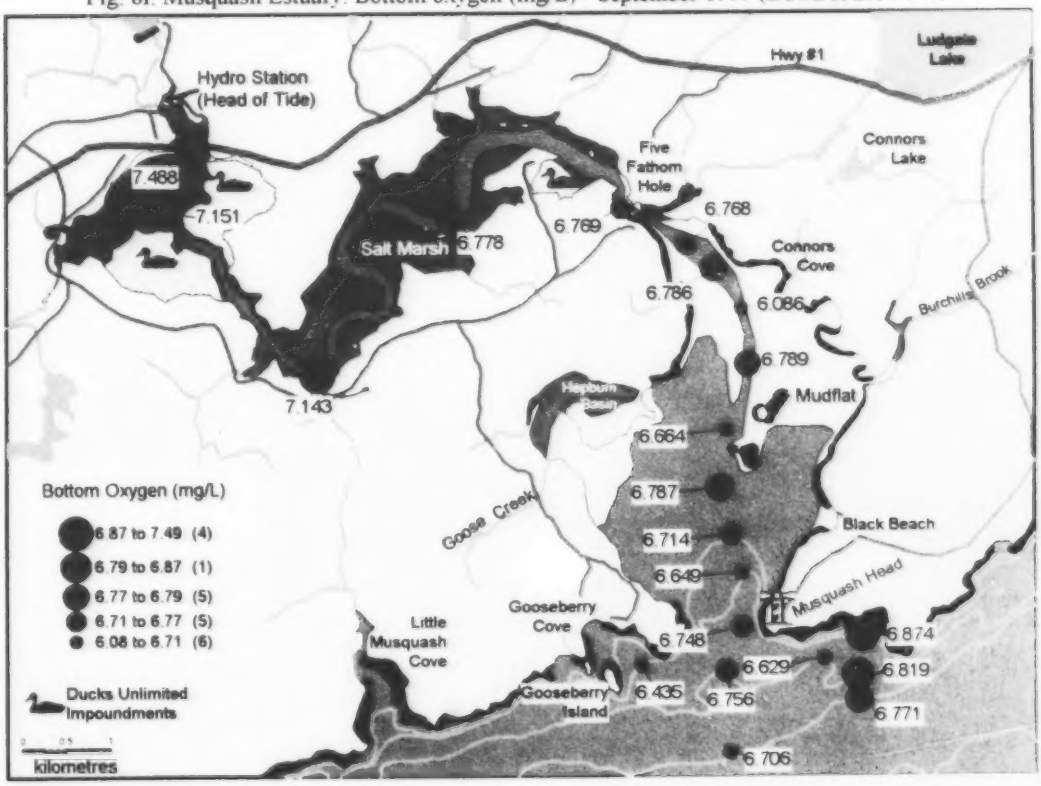


Fig 8g Musquash Estuary Surface chlorophyll concentration (Flouresence Units) - September 1999 (Dowd et al., 1999).

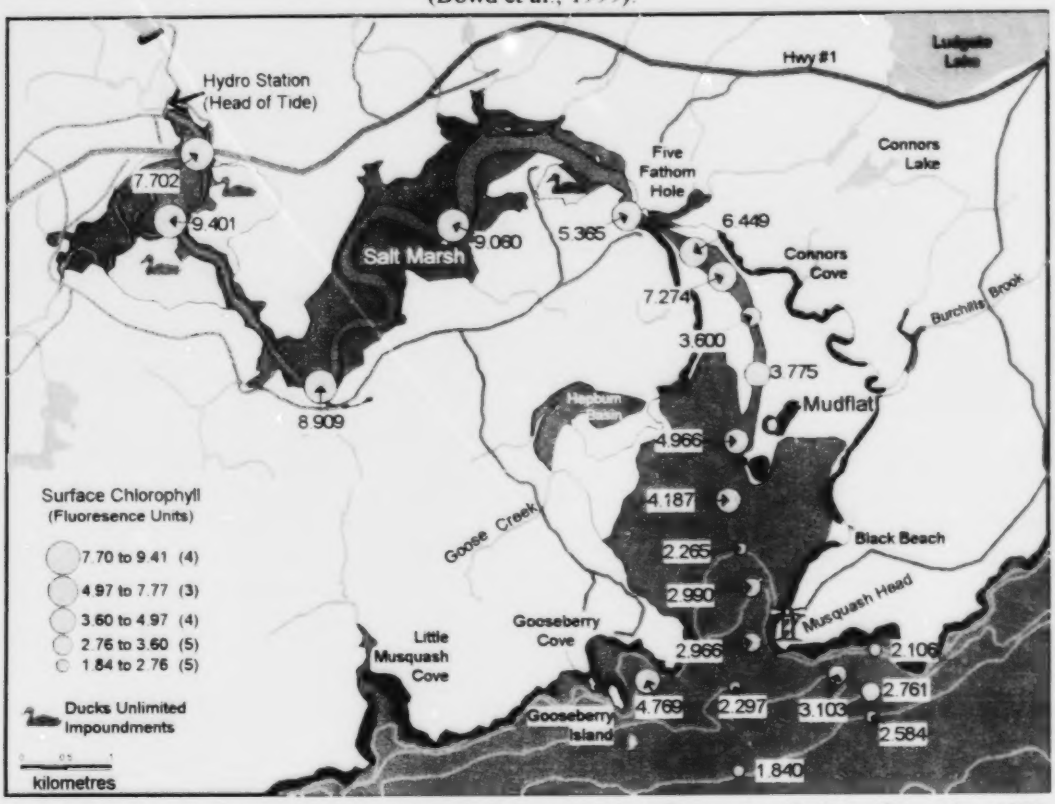


Fig. 8h. Musquash Estuary Bottom chlorophyll concentration (Fluoresence Units) - September 1999 (Dowd et al., 1999).

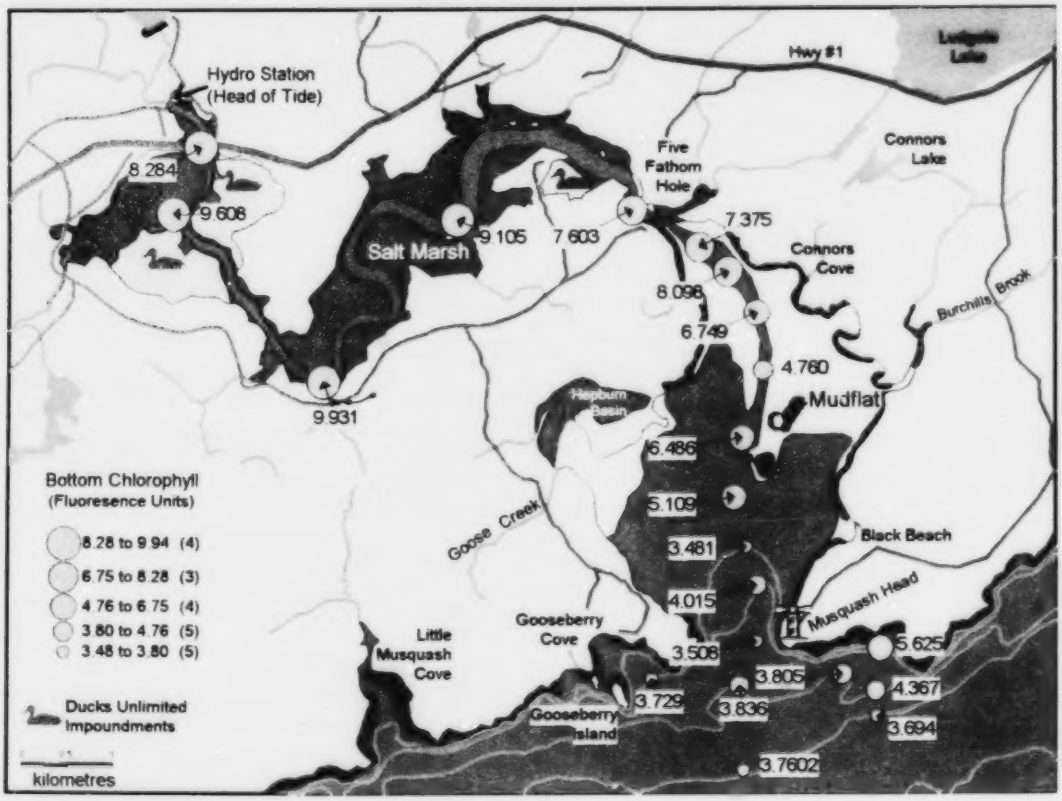


Fig. 8i. Musquash Estuary. Surface turbidity (Formazin Turbidity Units) - Sept. 1999 (Dowd et al., 1999)

Fig. 8j. Musquash Estuary. Bottom turbidity (Formazin Turbidity Units) - Sept. 1999 (Dowd et al., 1999)

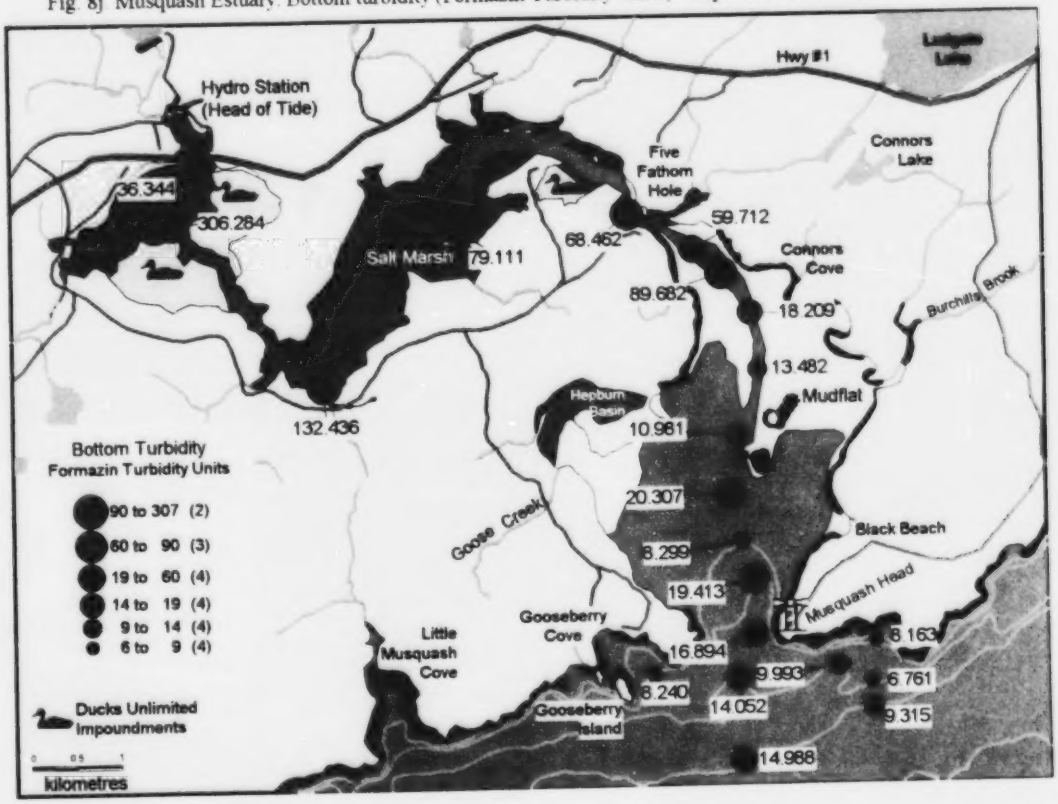


Fig. 8k. Musquash Estuary: Surface water density (Sigma-t in kg/m^3) - Sept. 1999 (Dowd et al., 1999).

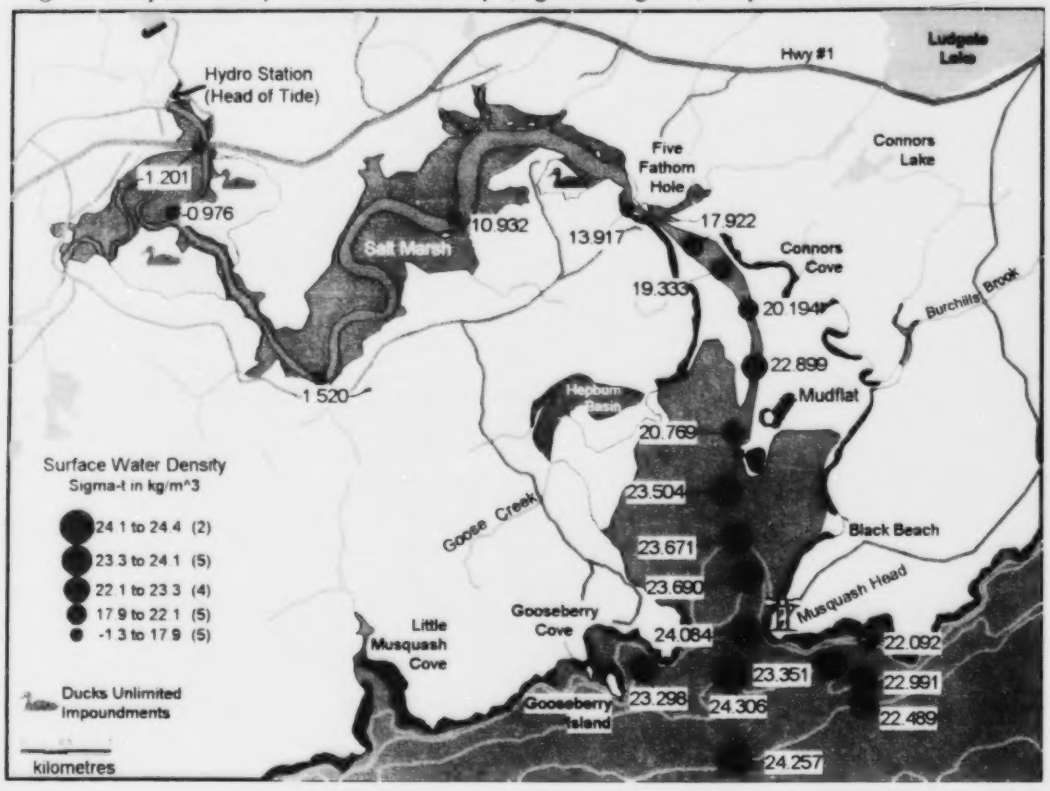
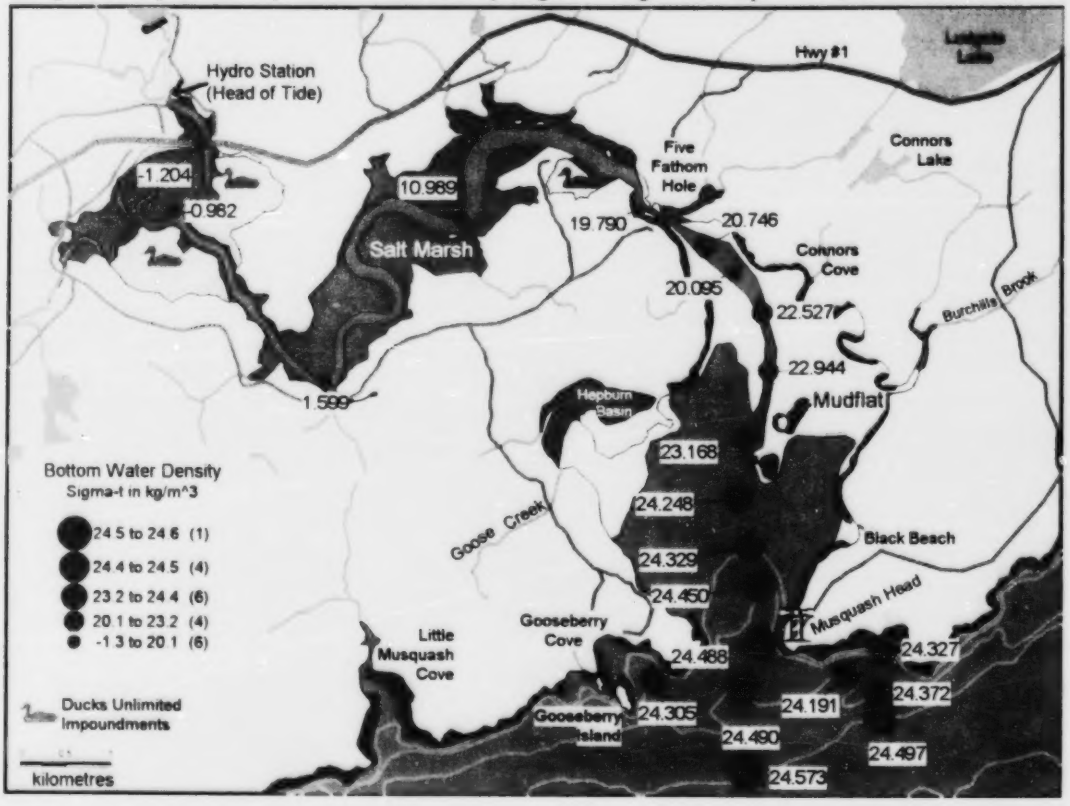


Fig. 8l. Musquash Estuary: Bottom water density (Sigma-t in kg/m^3) - Sept. 1999 (Dowd et al., 1999).



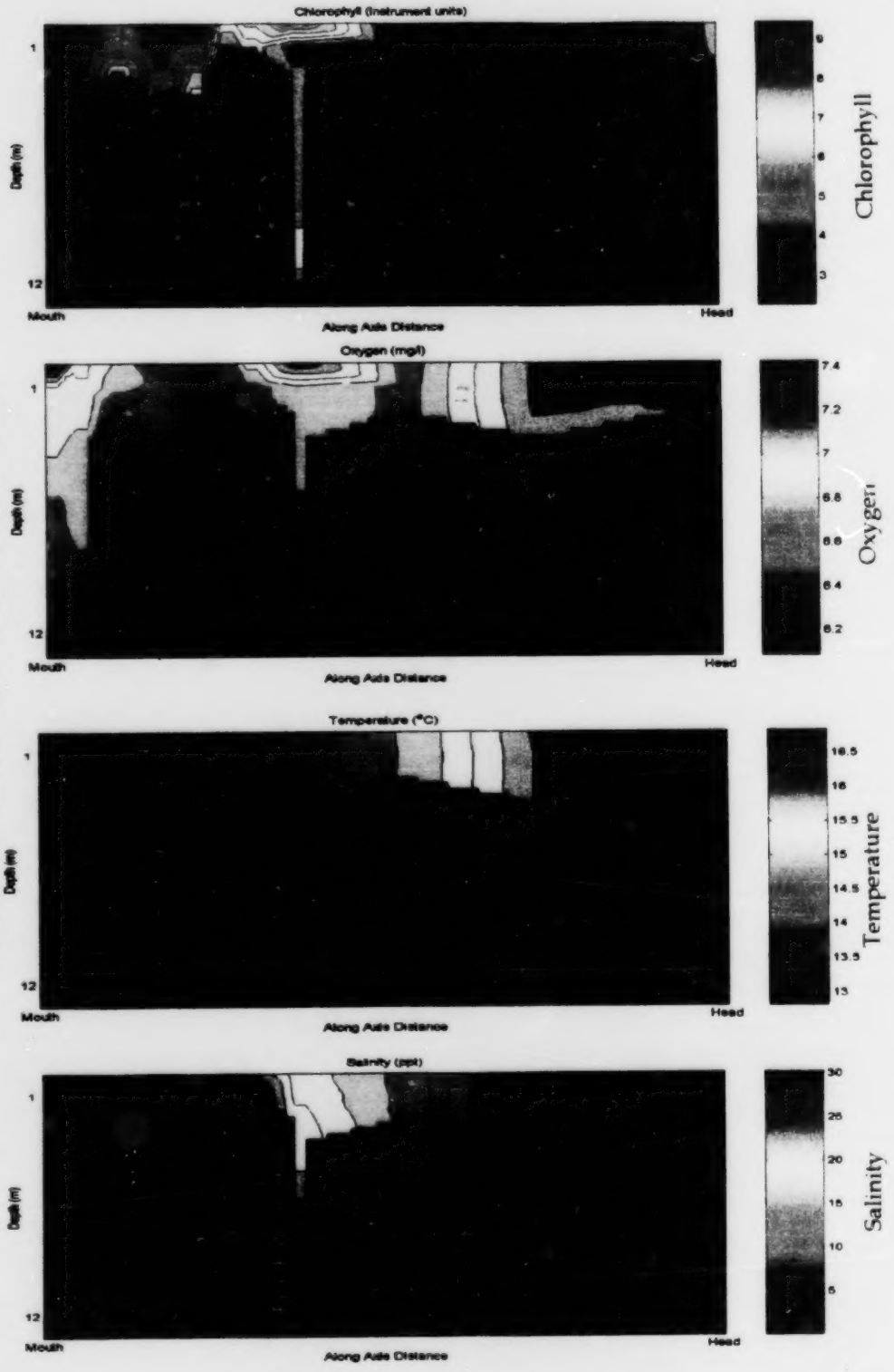


Fig. 8m. Section plots along-axis gradient from station 7 (Mouth of estuary) to station 18 (Highway #1 Bridge, Head) plotted based on the straight line distance between the stations (Dowd et al., 1999).

Fig 9a Musquash Harbour and Coast: Water Quality stations sampled in August and October 1974 (MacKay, 1975).

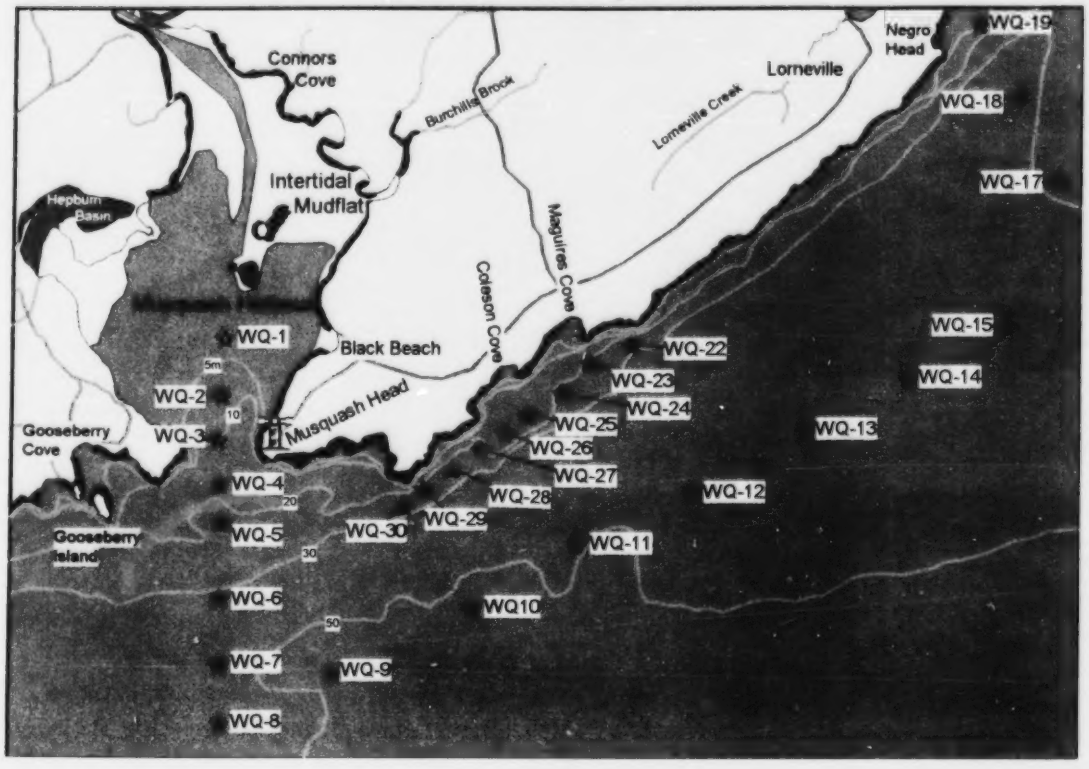


Fig. 9b. Musquash Harbour and Coast: High lead concentrations above 0.01 mg/L (MacKay, 1975).

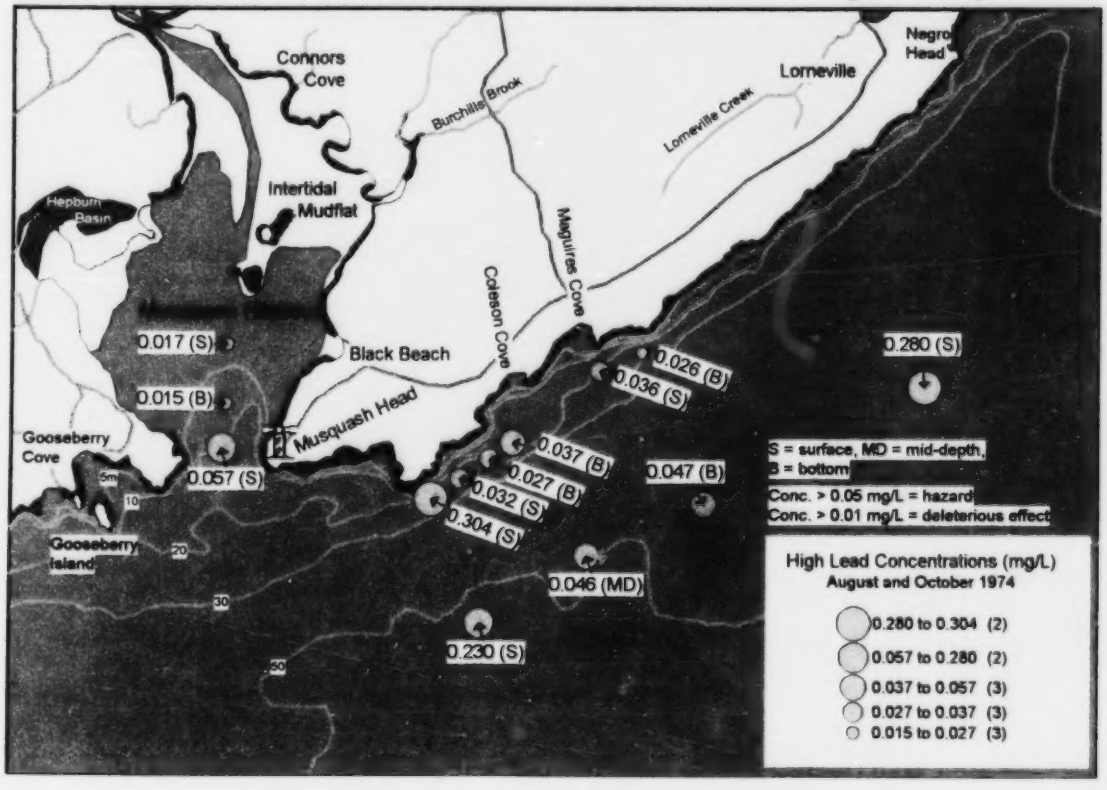


Fig. 9c. Musquash Harbour and Coast: High mercury concentrations above 0.010 mg/L (MacKay, 1975)

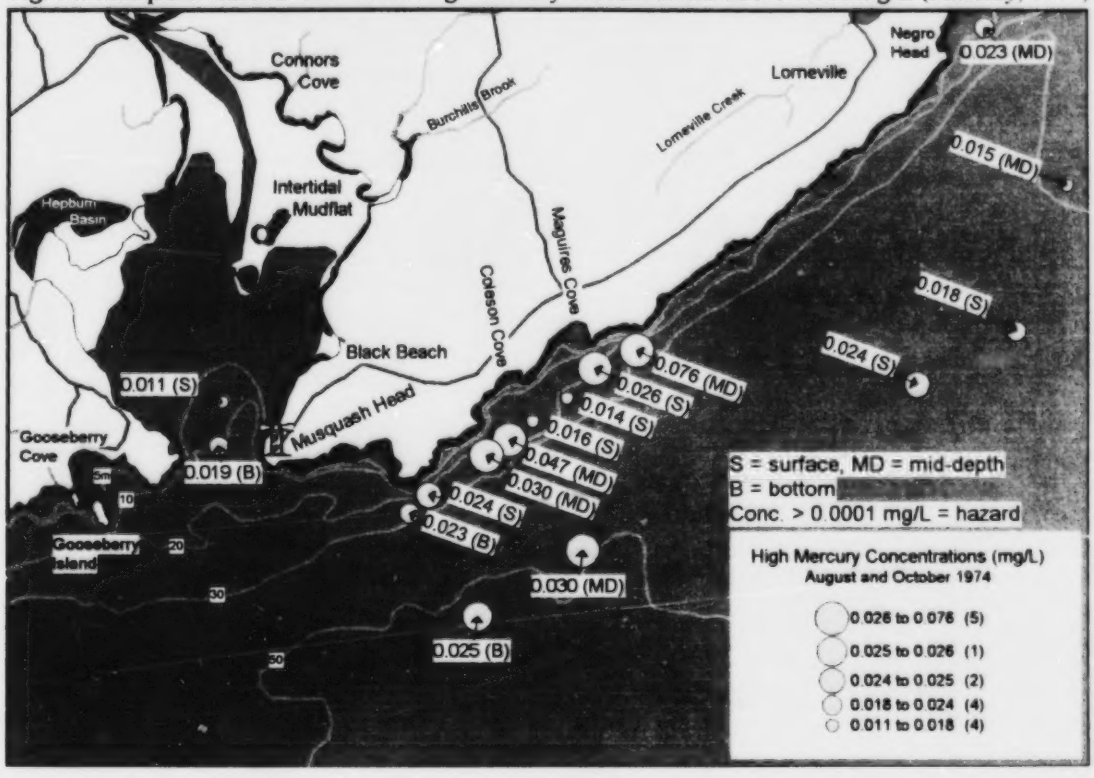


Fig. 9d. Musquash Harbour and Coast: High copper concentrations above 0.010 mg/L (MacKay, 1975)

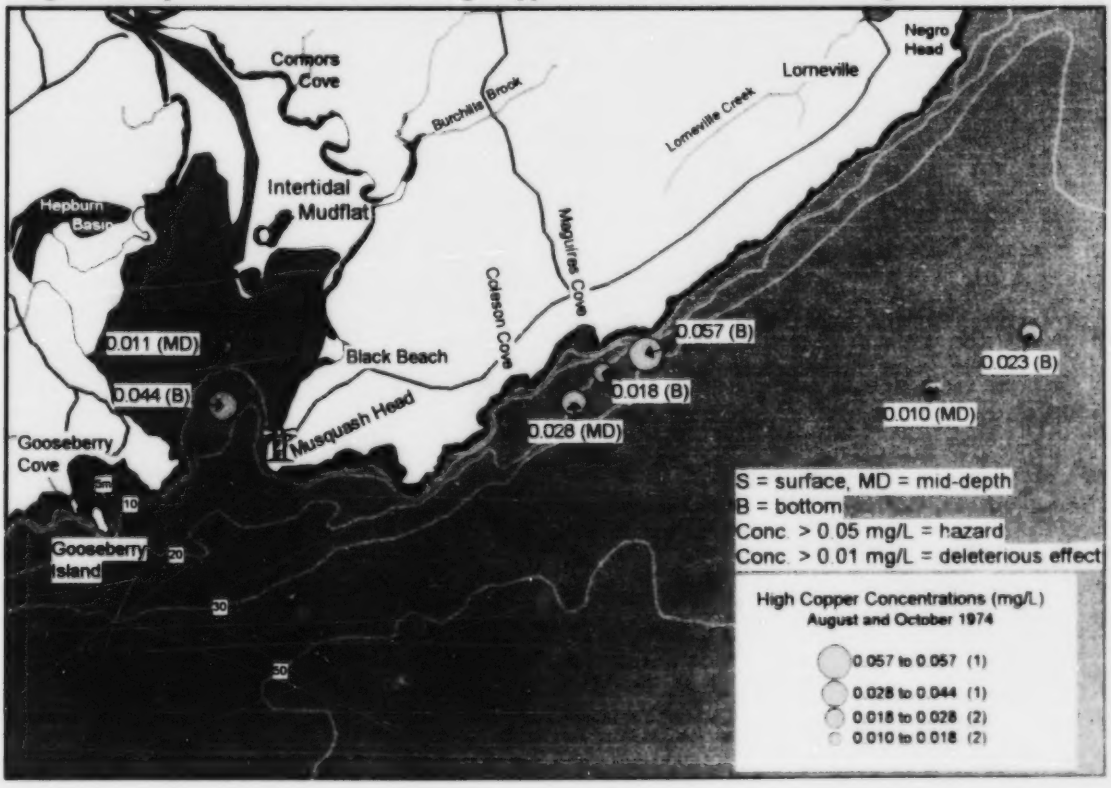


Fig. 10 Musquash Estuary. Maximum fecal coliform densities (MPN/100mL) in samples taken during mid-tide for the period 1989-1997 (Richard et al., 1998)

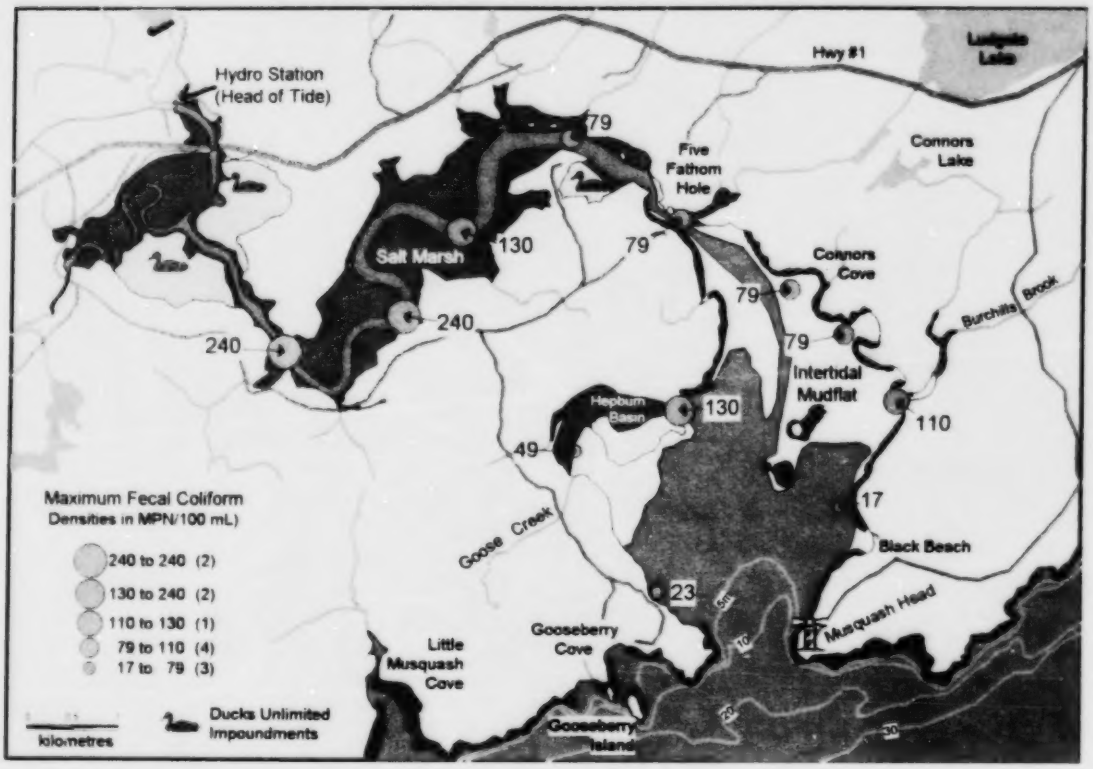


Fig. 11a. Musquash Estuary: Number of species per m^2 sampled in June 1973 (Wildish, 1977, 1983)

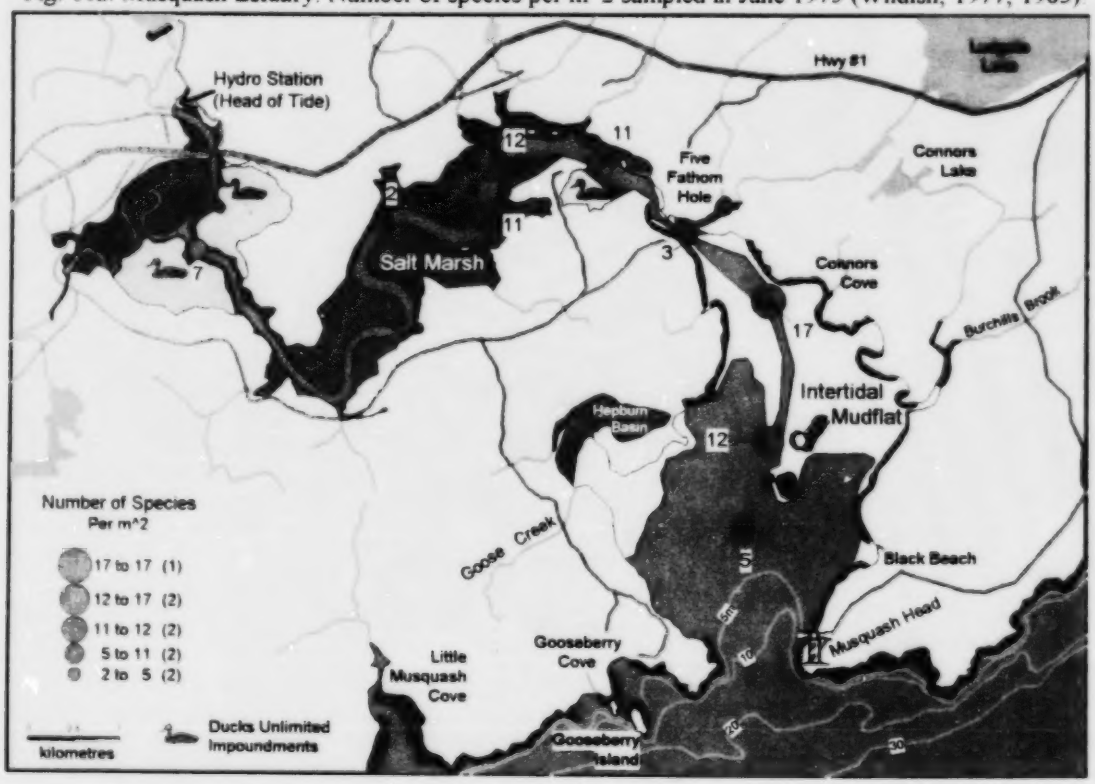


Fig. 11b Musquash Estuary: Sediment Sorting Coefficient (QD phi) in June 1973 (Wildish 1977, 1983)

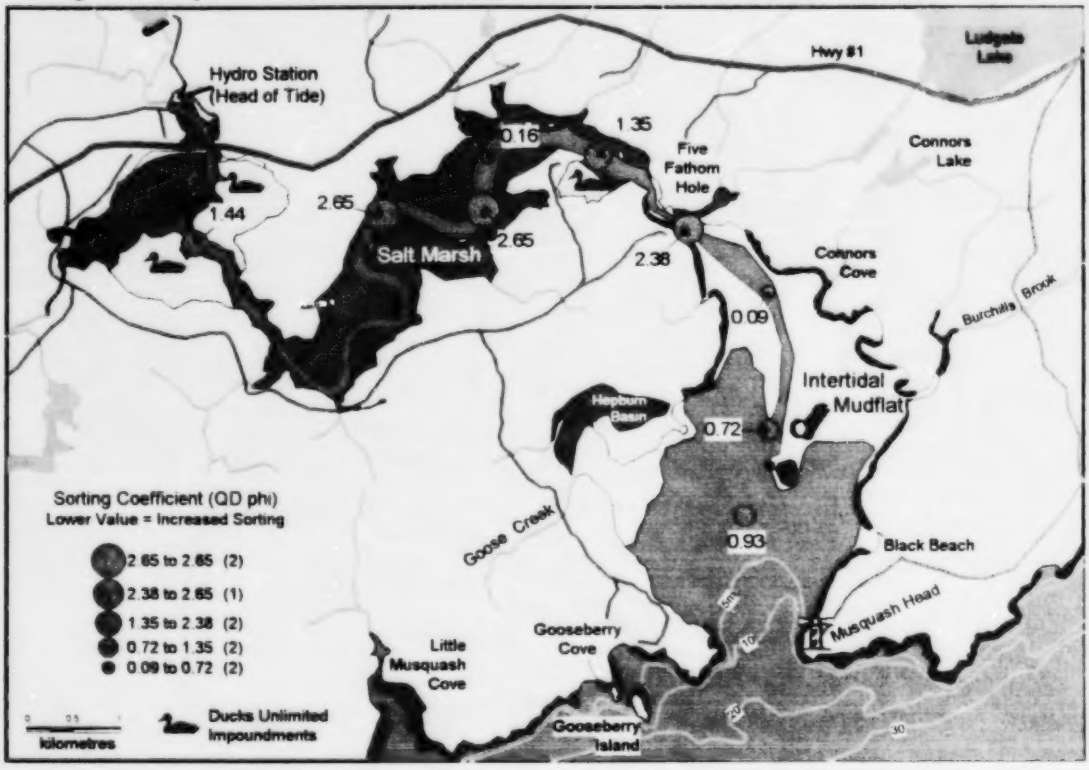


Fig. 11c Musquash Estuary: Organic carbon (% dry weight) in June 1973 (Wildish 1977, 1983)

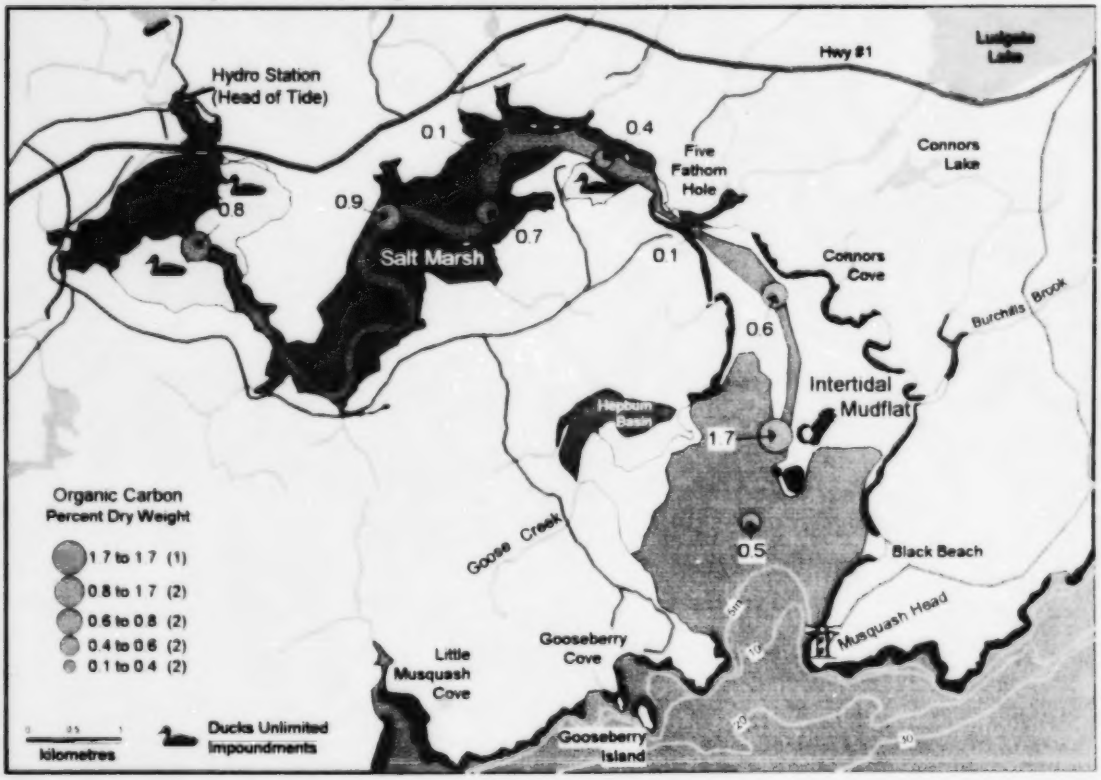


Fig. 11d Musquash Estuary: Biomass per m^2 sampled in June 1973 (Wildish, 1977, 1983).

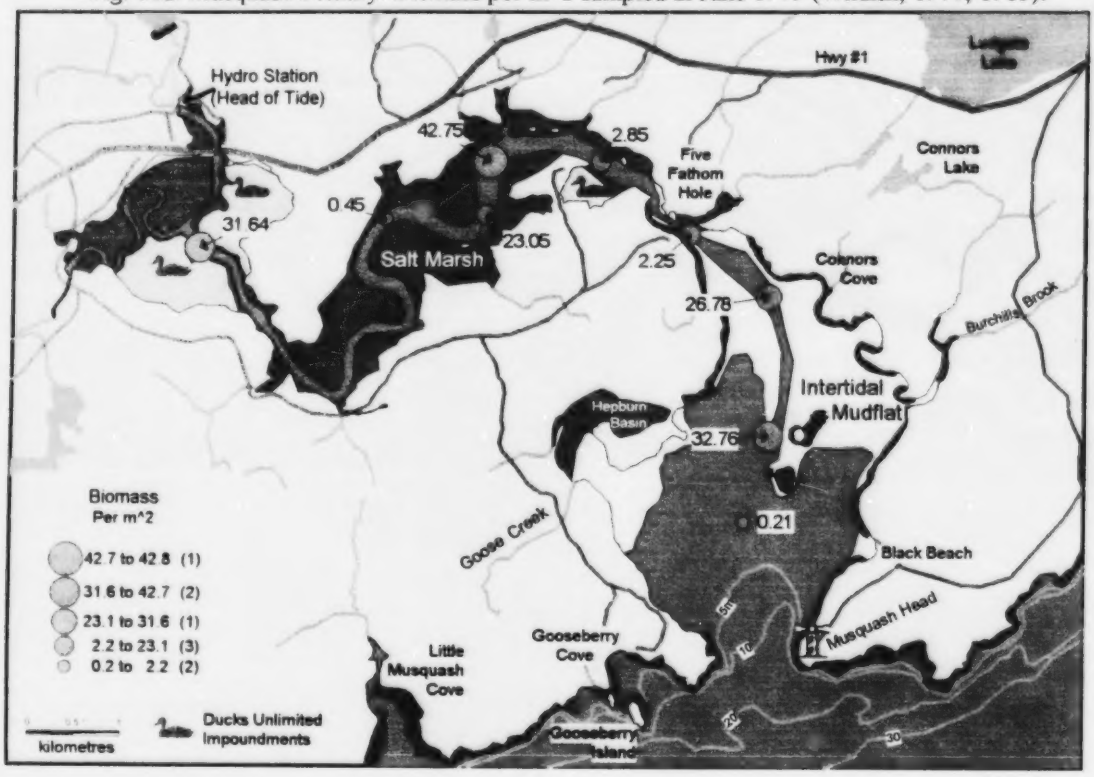


Fig. 11e. Musquash Estuary: Number of individuals per m^2 sampled in June 1973 (Wildish, 1977, 1983).

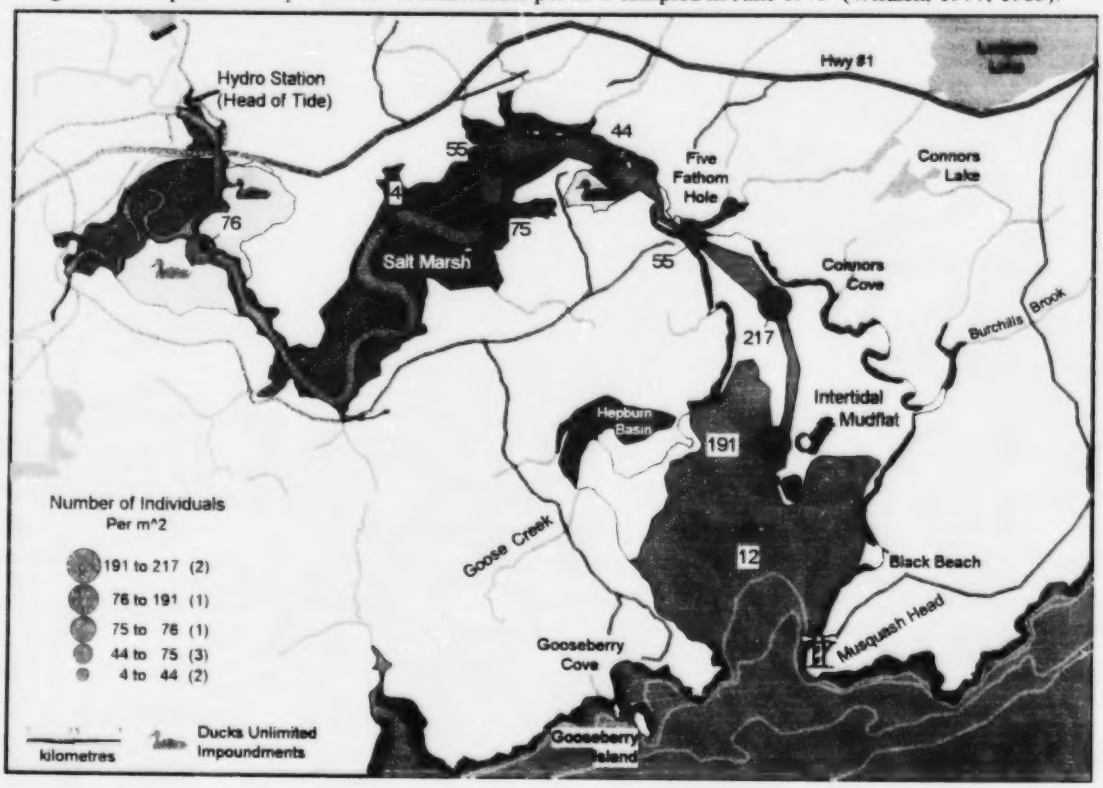


Fig. 12a. Musquash Harbour: Lobster fishing area at the mouth of the estuary (CCRM, 1999).

Fig. 12b. Musquash Harbour: Rock crab fishing area at the mouth of the estuary (CCRM, 1999).

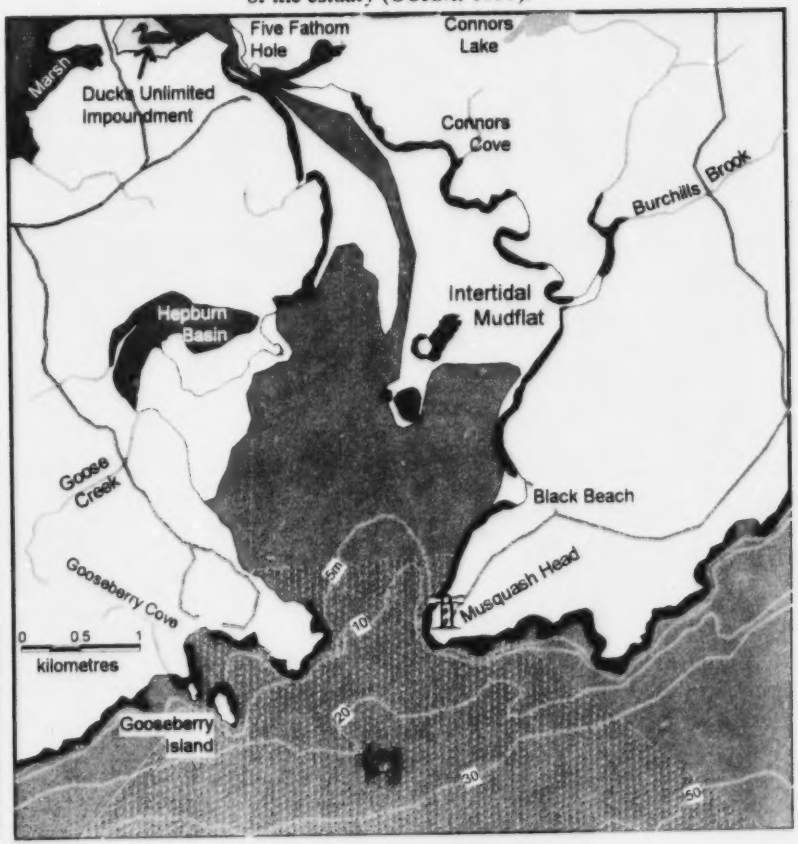


Fig. 12c. Musquash: Areas of soft-shell clam beds (CL), sea urchins (SU), Gooseberry Cove herring shut-off area, seal haul-out areas, scallop bed (CCRM, 1999).

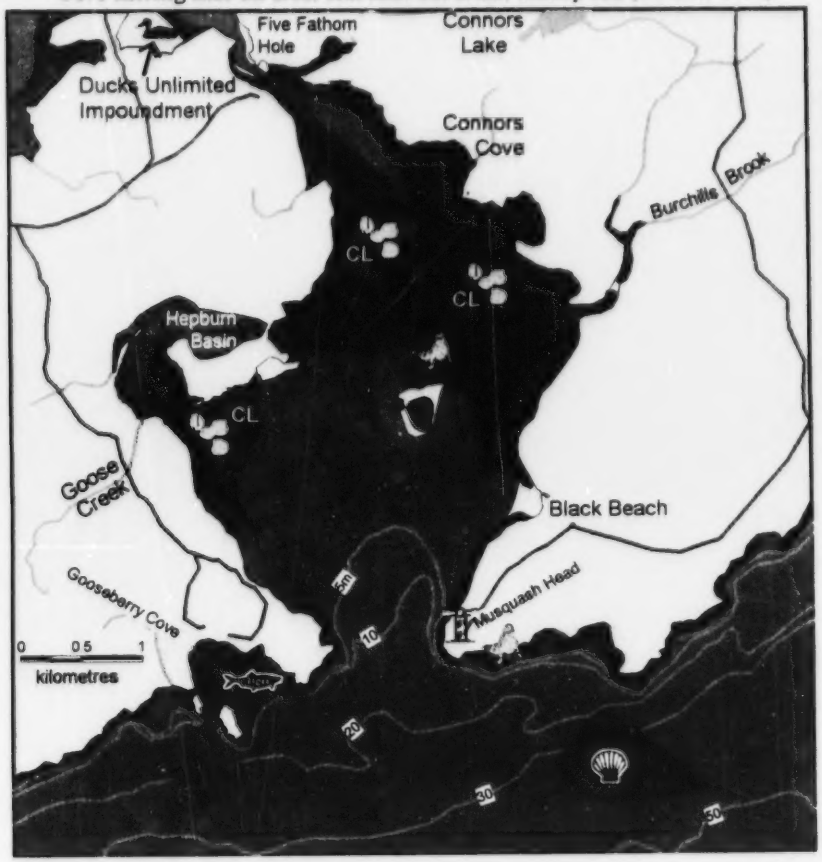


Fig. 12d. Musquash Harbour: High rockweed (RW) and periwinkle (arrows Musquash Island and Gooseberry Cove) density areas (CCRM, 1999).

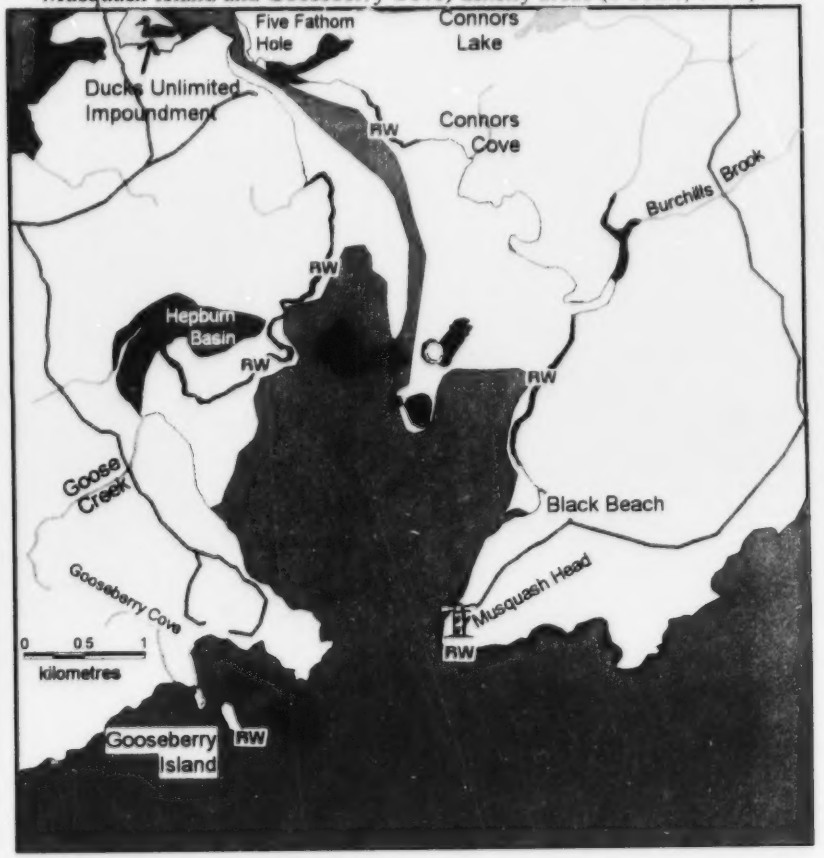


Fig. 12e. Musquash Estuary. Clam beds (hatched red areas) and periwinkle (PW) harvesting areas (Thompson, 2000).

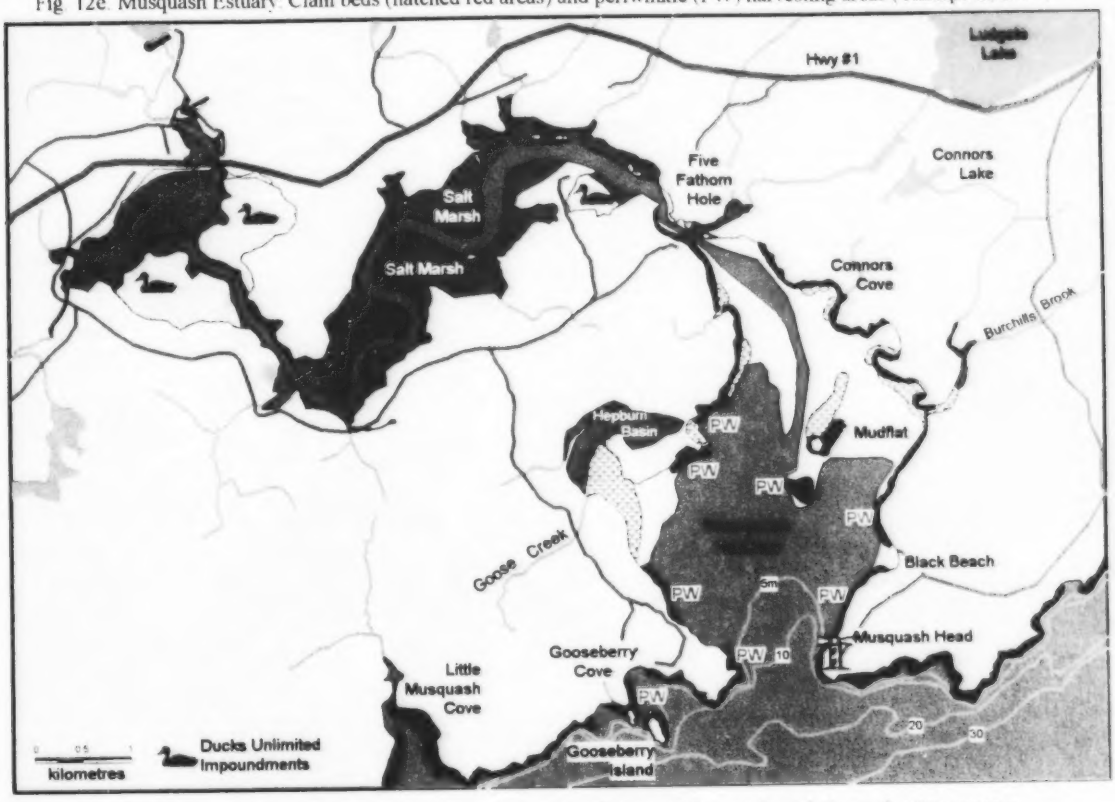


Fig. 13. Musquash Estuary. Total number of species (flora and fauna) found along the 9 transects in September 1974 (Mackay 1975).

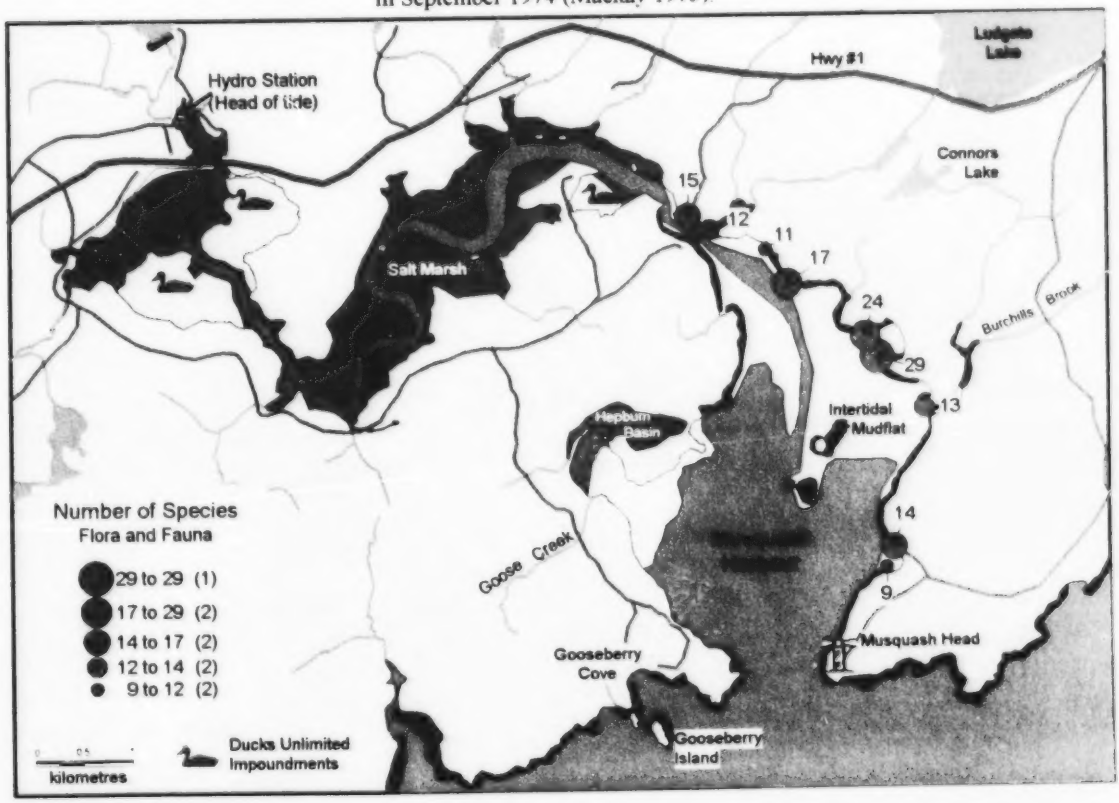


Fig. 14a Musquash Estuary. Numbers of bird species observed in 1999 (Deichmann, 1999).

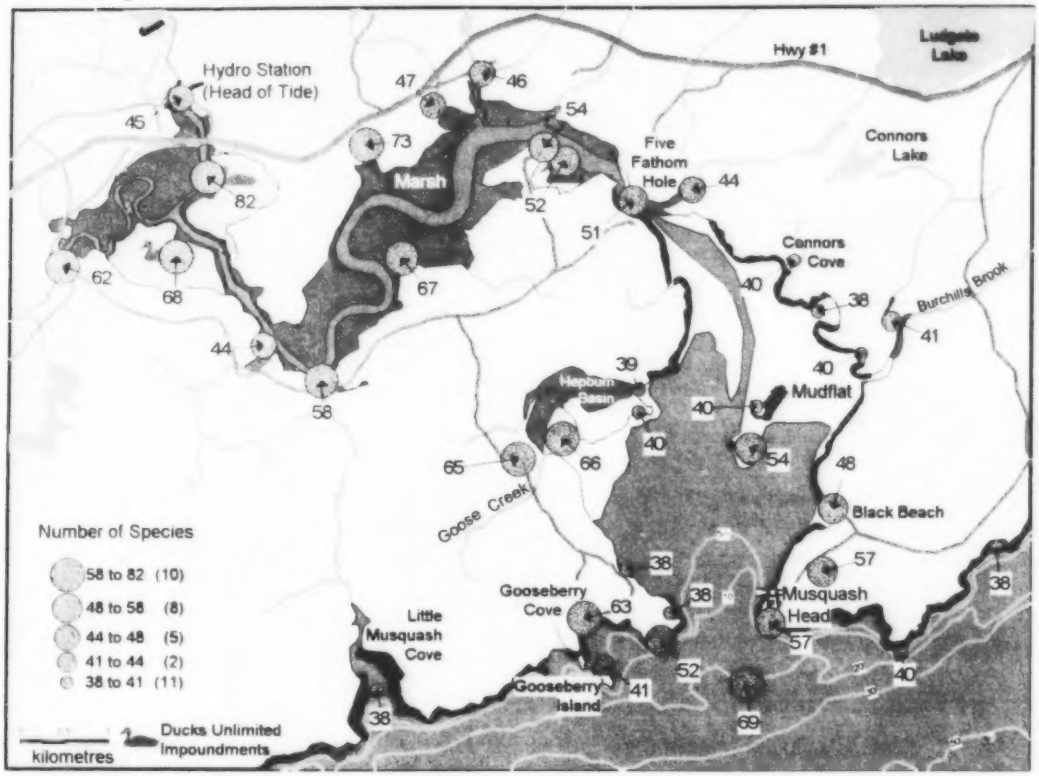


Fig. 14b Musquash Harbour. Sightings of migratory birds (DUIs A and B) and of nesting/breeding birds (CCRM, 1999); and locations of Eiders sighted by Deichmann (1999).

Appendix 1

Musquash Estuary

General Species List
(Incomplete)

Compiled from published and unpublished sources.

FLORA

Phylum	Class/Family	Species name	Common Name	Reference
Dinoflagellate	Dinophyceae	*Alexandrium fundyense*		Martin & LeGresley (this report)
	Dinophyceae	*Ceratium fusus*		Martin & LeGresley (this report)
	Dinophyceae	*Ceratium longipes*		Martin & LeGresley (this report)
	Dinophyceae	*Dinophysis acuminata*		Martin & LeGresley (this report)
	Dinophyceae	*Heterocapsa triquetra*		Martin & LeGresley (this report)
	Dinophyceae	*Prorocentrum micans*		Martin & LeGresley (this report)
	Dinophyceae	*Protoperidinium sp.*		Martin & LeGresley (this report)
	Dinophyceae	Armoured dinoflagellate		Martin & LeGresley (this report)
	Dinophyceae	Unarmoured dinoflagellate		Martin & LeGresley (this report)
Diatom	Bacillariophyceae	*Achnanthes* sp.		Martin & LeGresley (this report)
	Bacillariophyceae	*Actinoptychus senarius*		Martin & LeGresley (this report)
	Bacillariophyceae	*Asterionellopsis glacialis*		Martin & LeGresley (this report)
	Bacillariophyceae	*Cerataulina pelagica*		Martin & LeGresley (this report)
	Bacillariophyceae	*Chaetoceros socialis*		Martin & LeGresley (this report)
	Bacillariophyceae	*Chaetoceros* sp.		Martin & LeGresley (this report)
	Bacillariophyceae	*Chaetoceros subtilis*		Martin & LeGresley (this report)
	Bacillariophyceae	*Corathron criophilum*		Martin & LeGresley (this report)
	Bacillariophyceae	*Coscinodiscus sp.*		Martin & LeGresley (this report)
	Bacillariophyceae	*Cylindrotheca closterium*		Martin & LeGresley (this report)
	Bacillariophyceae	*Ditylum brightwellii*		Martin & LeGresley (this report)
	Bacillariophyceae	*Eucampia zodiacus*		Martin & LeGresley (this report)
	Bacillariophyceae	*Guinardia delicatula*		Martin & LeGresley (this report)
	Bacillariophyceae	*Leptocylindrus minimus*		Martin & LeGresley (this report)
	Bacillariophyceae	*Navicula* sp.		Martin & LeGresley (this report)
	Bacillariophyceae	*Paralia marina*		Martin & LeGresley (this report)
	Bacillariophyceae	*Pseudo-nitzschia delicatissima-group*		Martin & LeGresley (this report)
	Bacillariophyceae	*Rhizosolenia setigera*		Martin & LeGresley (this report)
	Bacillariophyceae	*Skeletonema costatum*		Martin & LeGresley (this report)
	Bacillariophyceae	*Thalassiosira oestrupii*		Martin & LeGresley (this report)
	Bacillariophyceae	*Thalassiosira sp.*		Martin & LeGresley (this report)
	Bacillariophyceae	Pennate diatom		Martin & LeGresley (this report)
	Bacillariophyceae	Centric diatom		Martin & LeGresley (this report)
Flagellate	Chrysophyceae	*Dinobryon* sp.		Martin & LeGresley (this report)
Flagellate	Dictyochophyceae	*Dictyocha speculum*		Martin & LeGresley (this report)
Ciliate	Litostomatea	*Mesodinium rubrum*		Martin & LeGresley (this report)
Ciliate	Choreotrichida	Tintinnids		Martin & LeGresley (this report)
Flagellate	Euglenophyceae	Flagellate-*Eutreptiella* sp.?		Martin & LeGresley (this report)
Myxophyceans		Myxophyceans		MacKay (1975)
Intertidal-Lichens	Lichen	*Acarospora fuscata*		Stevens (1997)
	Lichen	*Acarospora samragdula*		Stevens (1997)
	Lichen	*Caloplaca elegans*		Stevens (1997)
	Lichen	*Caloplaca marina*		Stevens (1997)
	Lichen	*Cladonia chlorophaea*		Stevens (1997)
	Lichen	*Cladonia coccifera*		Stevens (1997)
	Lichen	*Cladonia ecmocyna*		Stevens (1997)
	Lichen	*Cladonia leporina*		Stevens (1997)
	Lichen	*Lecanora grantii*		Stevens (1997)
	Lichen	*Lepraria membranacea*		Stevens (1997)
	Lichen	*Normandina pulchella*		Stevens (1997)
	Lichen	*Parmelia (Xanthoparmelia) conspera*		Stevens (1997)
	Lichen	*Parmelia saxatilis*		Stevens (1997)
	Lichen	*Parmelia sulcata*		Stevens (1997)
	Lichen	*Rhizocarpon constrictum*		Stevens (1997)
	Lichen	*Rhizocarpon obscuratum*		Stevens (1997)
	Lichen	*Verrucaria maura*	Smooth-black encrusting	MacKay ('75), Stevens ('97)
	Lichen	*Verrucaria ceuthocarpa*		Stevens (1997)
	Lichen	*Verrucaria microspora*		Stevens (1997)
	Lichen	*Verrucaria mucosa*		Stevens (1997)
	Lichen	*Xanthoria elegans*		Stevens (1997)
	Lichen	*Xanthoria parietina*		Stevens (1997)
	Lichen	*Lichina pygmaea*		MacKay (1975)
Byrophytes	Byrophyta	*Bryum salinum*		Stevens (1997)
	Byrophyta	*Pohlia elongata*		Stevens (1997)
	Byrophyta	*Pohlia nutans*		Stevens (1997)
	Byrophyta	*Tetradantrium brownianum*		Stevens (1997)
Algae	Cyanophyta	*Lyngbya* sp.	Blue-green algae	Stevens (1997)
	Chlorophyta	*Enteromorpha intestinalis*		Thomas & Page ('83), Stevens ('97)
	Chlorophyta	*Enteromorpha compressa*		Stevens (1997)
	Chlorophyta	*Ulva lactuca*	Sea lettuce	MacKay ('75), Stevens ('97)
	Chlorophyta	*Chaetomorpha linum*		MacKay ('75), Stevens ('97)
	Chlorophyta	*Chaetomorpha melagonium*		MacKay ('75), Stevens ('97)
	Chlorophyta	*Cladophora albida*		Stevens (1997)
	Chlorophyta	*Cladophora glaucescens*		Stevens (1997)
	Chlorophyta	*Cladophora rupestris*		Stevens (1997)
	Chlorophyta	*Cladophora gracilis*		UNBSJ BIOL 3173 (1994)
	Chlorophyta	*Monostroma grevillei*	Sea lettuce	Stevens (1997)
	Chlorophyta	*Monostroma oxyspermum*	Sea lettuce	Stevens (1997)
	Chlorophyta	*Acrosiphonia arcta*		Thomas & Page ('83)
	Chlorophyta	*Spongomorpha arcta*		Stevens (1997)
	Chlorophyta	*Rhizoclonium* sp.		Stevens (1997)
	Chlorophyta	*Ulothrix flacca*		Stevens (1997)
	Chlorophyta	*Urospora penicilliformis*		Stevens (1997)
	Phaeophyta	*Agarum cribrosum*		Stevens (1997)
	Phaeophyta	*Alaria esculenta*		Stevens (1997)
	Phaeophyta	*Ascophyllum nodosum*	Knotted Wrack (Rockweed)	MacKay (1975)
	Phaeophyta	*Chorda filum*		UNBSJ BIOL 3173 (1994)
	Phaeophyta	*Ectocarpus paradoxus*		MacKay ('75), Stevens ('97)
	Phaeophyta	*Ectocarpus siliculosus*		Stevens (1997)
	Phaeophyta	*Ectocarpus tomentosus*		Stevens (1997)
	Phaeophyta	*Fucus distichus distichus*	Bladder Wrack	Stevens (1997)
	Phaeophyta	*Fucus distichus edentatus*	Bladder Wrack	Thomas & Page ('83), Stevens ('97)
	Phaeophyta	*Fucus vesiculosus*	Bladder Wrack	MacKay ('75), Stevens ('97)
	Phaeophyta	*Fucus vesiculosus evesiculosus*		Stevens (1997)
	Phaeophyta	*Fucus spiralis*		Stevens (1997)
	Phaeophyta	*Laminaria digitata*	Kelp	Thomas & Page ('83), Stevens ('97)
	Phaeophyta	*Laminaria saccharina*	Kelp	Stevens (1997)
	Phaeophyta	*Petalonia fascia*		Stevens (1997)
	Phaeophyta	*Ralfsia fungiformis*		Stevens (1997)
	Rhodophyta	*Anfeltia plicata*		Stevens (1997)
	Rhodophyta	*Audouinella (Rhodocorten) purpurea*		Stevens (1997)

Phylum	Class/Family	Species name	Common Name	Reference
	Rhodophyta	*Ceramium rubrum*		Thomas & Page ('83), Stevens ('97)
	Rhodophyta	*Chondrus crispus*	Irish moss	Thomas & Page ('83), Stevens ('97)
	Rhodophyta	*Cystoclonium purpurascens*		UNBSJ BIOL 3173 (1994)
	Rhodophyta	*Corallina officinalis*	Feathery Pink Coralline algae	Thomas & Page ('83), Stevens ('97)
	Rhodophyta	*Gigartina stellata*	Agar Weed	MacKay (1975)
	Rhodophyta	*Devaleraea (Halosacchion) ramentaceum*		Thomas & Page ('83), Stevens ('97)
	Rhodophyta	*Dumontia incrassata (D. contorta)*		Stevens (1997)
	Rhodophyta	*Hildenbrandia prototypus (H. rubra)*		MacKay ('75), Stevens ('97)
	Rhodophyta	*Lithothamnion glaciale*		MacKay ('75), Stevens ('97)
	Rhodophyta	*Mastocarpus stellatus*		Stevens (1997)
	Rhodophyta	*M. stellatuc "Petrocelis" stage*		Stevens (1997)
	Rhodophyta	*Petrocelis middendorfi (M. sporoph.?)*		Thomas & Page ('83), Stevens ('97)
	Rhodophyta	*Palmaria palmata*	Dulse	Stevens (1997)
	Rhodophyta	*Phycodrys rubens*		Stevens (1997)
	Rhodophyta	*Phyllophora truncata*		Stevens (1997)
	Rhodophyta	*Phymatolithon lenormandii*	Pink Encrusting Coralline algae	Thomas & Page ('83), Stevens ('97)
	Rhodophyta	*Plumaria elegans*		Stevens (1997)
	Rhodophyta	*Polyides rotundus*		Stevens (1997)
	Rhodophyta	*Polysiphonia lanosa*	Epihpytic red algae	MacKay ('75), Stevens ('97)
	Rhodophyta	*Polysiphonia urceolata*		Stevens (1997)
	Rhodophyta	*Porphyra umbilicus*		Thomas & Page ('83), Stevens ('97)
	Rhodophyta	*Ptilota serrata*		Stevens (1997)
	Rhodophyta	*Rhodomela confervoides*		Stevens (1997)
Monocotyledonae	Gramineae	*Deschampsia flexuosa*	Wavy hairgrass	Stevens (1997), Hinds (1999)
(Grasses)	Poaceae	*Spartina alterniflola*	Salt marsh cord grass	Stevens (1997), Hinds (1999)
	Poaceae	*Spartina patens*	Salt marsh (meadow) hay	Stevens (1997), Hinds (1999)
	Poaceae	*Spartina pectinata*	Slough grass	Stevens (1997)
		Hordeum jubatum	Foxtail barley	Stevens (1997)
	Poaceae	*Hierochloa ordatata*	Indian/vanilla/sweet grass	Hinds (1999)
	Juncaceae	*Juncus gerardi*	Black grass	Stevens (1997), Hinds (1999)
	Juncaceae	*Juncus filiformis*	Thread Rush	Stevens (1997), Hinds (1999)
	Juncaceae	*Triglochin maritima*	Arrow grass	Stevens (1997), Hinds (1999)
	Cyperaceae	*Scripus americanus*	Bulrush	Stevens (1997)
	Cyperaceae	*Carex palaecea*	Sedge	Stevens (1997)
	Cyperaceae	*Carex mackenziei*	MacKenzie's sedge	Hinds (1999)
	Cyperaceae	*Eleocharis halophila*	Saltmarsh spike-rush	Hinds (1999)
		Cotula coronopifolia	Brass buttons	Stevens (1997)
		Agropyron repens	Quackgrass	Stevens (1997)
	Poaceae	*Phleum pratense*	Timothy	Stevens (1997), Hinds (1999)
Spermatophyta	Pinaceae	*Abies balsamea*	Balsam Fir	Stevens (1997), Hinds (1999)
	Pinaceae	*Picea glauca*	White Spruce	Stevens (1997), Hinds (1999)
Dicotyledonae	Compositae	*Achillea millefolium*	Yarrow, Milfoil	Stevens (1997), Hinds (1999)
	Betulaceae	*Alnus crispa*	Downy Alder	Stevens (1997)
	Compositae	*Aster* sp.	Aster	Stevens (1997), Hinds (1999)
	Empetraceae	*Empetrum nigrum*	Black Crowberry	Stevens (1997), Hinds (1999)
	Umbelliferae	*Ligusticum scothicum*	Scotch Lovage	Stevens (1997), Hinds (1999)
	Plantaginaceae	*Plantago maritima*	Seaside Plantain	Stevens (1997), Hinds (1999)
	Rosaceae	*Rosa carolina*	Rose	Stevens (1997)
	Rubiaceae	*Galium trifidum*	Three-petalled bedstraw	Hinds (1999)
	Compositae	*Solidago sempervirens*	Seaside Goldenrod	Stevens (1997), Hinds (1999)
	Rosaceae	*Spiraea tomentosa*	Steeplebush	Stevens (1997)
	Ericaceae	*Vaccinium macrocarpon*	Large Cranberry	Stevens (1997), Hinds (1999)
	Ericaceae	*Vaccinium vitis-idaea*	Mountain cranberry	UNBSJ BIOL 3173 ('94), Hinds ('99)
	Chenopodiaceae	*Suaeda maritima*	Atlantic sea blite	Stevens (1997), Hinds (1999)
	Chenopodiaceae	*Atriplex patula*	Common orache	Stevens (1997), Hinds (1999)
	Chenopodiaceae	*Salocornia europea*	Glasswort, Samphire	Stevens (1997)
	Caryophyllaceae	*Spergularia canadensis*	Sand Spurrey	Stevens (1997)
	Primulaceae	*Glaux maritima*	Sea milkwort	Stevens (1997), Hinds (1999)
	Plumbaginaceae	*Limonium nashii*	Sea lavender	Stevens (1997)
	Rosaceae	*Potentilla anserina*	Silverweed	Stevens (1997)
	Ranunulaceae	*Ranunculus cymbalaria*	Seaside buttercup (Crowfoot)	Stevens (1997), Hinds (1999)
	Saxifragaceae	*Ribes* sp.	Gooseberry	UNBSJ BIOL 3173 (1994)
			FAUNA	
Porifera	Halichondridae	*Halichondria bowerbanki*		Stevens (1997)
(Sponges)	Halichondridae	*Halichondria panicea*		Stevens (1997)
	Haliclonidae	*Haliclona loosanoffi*		Stevens (1997)
	Haliclonidae	*Haliclona oculata*		Stevens (1997)
Nematode		Unknown		Gratto (1986)
Platyhelminthes		*Dalyelloida* sp.		Stevens (1997)
Nemertina	Lineidae	*Lineus bicolor*	Boot lace worm	Gratto ('86), Stevens ('97)
	Lineidae	*Lineus ruber*	Boot lace worm	Stevens (1997)
	Amphiporidae	*Amphiporus oraceus*	Boot lace worm	Stevens (1997)
	Tetrastemmatidae	*Tetrastemma canidum*		Stevens (1997)
Annelida	Hirrudinea	Unknown		Gratto (1986)
Polychaeta	Phyllodocidae	*Eteone longa*	Bristle worm	Gratto ('86), Stevens ('97)
	Sabellidae	*Fabricia sabella*	Bristle worm	Gratto (1986)
	Spionidae	*Streblospio benedicti*		Gratto (1986)
	Nereidae	*Nereis diversicolor*	Clam worm	Gratto ('86), Stevens ('97)
	Nereidae	*Nereis virens*	Clam (sand) worm	Gratto ('86), Stevens ('97)
	Nephtyidae	*Nephthys incisa*	Bristle worm	Wildish (1983)
	Nephtyidae	*Nephthys picata*		Stevens (1997)
	Nephtyidae	*Agleophamus neotena*		Gratto (1986)
	Spionidae	*Pygospio elegans*		Gratto (1986)
	Capitellidae	*Capitella capitata*	Bristle worm	MacKay ('75), Stevens ('97)
	Terebellidae	*Polycirrus* sp.	Bristle worm	MacKay (1975)
	Goniadidae	*Goniada maculata*		Wildish (1983)
	Lumbrinereidae	*Ninoe nigripes*		Wildish (1983)
	Sternaspidae	*Sternaspis scutata*	Bristle worm	Wildish (1983)
	Phyllodocidae	*Eulalia viridis*		Stevens (1997)
	Polynoidae	*Harmothoe imbricata*		Stevens (1997)
	Glyceridae	*Glycera dibranchiata*		Stevens (1997)
	Orbiniidae	*Naineris quadricuspida*		Stevens (1997)
	Sabellidae	*Potamilla reniformis*		Stevens (1997)
	Spionidae	*Scolecolepides viridis*		Stevens (1997)
	Serpulidae	*Spirobis borealis*		Stevens (1997)
Oligochaeta	Oligochaeta	Unknown		Gratto (1986)
	Tubificidae	*Peloscolex benedini*	Aquatic Earthworm	Gratto (1986)
	Enchytraeidae	*Enchytraeus albidus*	Aquatic Earthworm	Stevens (1997)
Byrozoa	Flustrellidridae	*Flustrellidra hispida*	Intertidal Byrozoan	MacKay ('75), Stevens ('97)
	Crisiidae	Unknown *(Crisia?)* sp.		Stevens (1997)
	Electridae	*Electra pilosa*		Stevens (1997)

Phylum	Class/Family	Species name	Common Name	Reference
	Flustridae	*Flustra foliaceae*		Stevens (1997)
Cnidaria	Actinidae	*Bunodactis stella*	Green (Gem) anemone	MacKay (1975)
	Metridiidae	*Metridium senile*	Plumose Anemone	Stevens (1997)
	Actinidae	*Tealia felina*	Dahlia Anemone	Stevens (1997)
	Ulmaridae	*Aurelia aurita (ephyra)*	Jellyfish	Stevens (1997)
	Sertularidae	*Sertularia pumila*		Stevens (1997)
	Plumulariidae	*Schizotricha tenella*		Stevens (1997)
Ctenophora	Pleurobrachiidae	*Pleurobranchia pileus*	Comb-jelly	Stevens (1997)
Crustacea	Crustacean	*Zoea larvae*		Gratto (1986)
	Copepoda	Harpacticiod		Gratto (1986)
	Copepoda	Calanoid		Gratto (1986)
	Copepoda	*Argulus* sp.		Gratto (1986)
	Cumacea	*Oxyurostylis smithi*	Cumacean Shrimp	Gratto (1986)
	Cumacea	*Leptocuma minor*	Cumacean Shrimp	Gratto (1986)
	Isopoda	*Jaera marina*	Isopod	Gratto ('86), Stevens ('97)
	Isopoda	*Idotea phosphorea*	Isopod	Wildish (1983)
	Isopoda	*Chiridotea coeca*	Isopod	Stevens (1997)
	Amphipoda	*Ampithoe rubricata*		Stevens (1997)
	Amphipoda	*Erichthonius rubricornis*		UNBSJ BIOL 3173 (1994)
	Amphipoda	*Hyale nilssoni*		Gratto (1986)
	Amphipoda	*Leptocheirus pinguis*		Wildish (1983)
	Amphipoda	*Corophium volutator*		Gratto (1986)
	Amphipoda	*Gammarus lawrencianus*		Gratto (1986)
	Amphipoda	*Gammarus angulosus*		Stevens (1997)
	Amphipoda	*Gammarus homari*		Stevens (1997)
	Amphipoda	*Gammarus mucronatus*		Gratto (1986)
	Amphipoda	*Orchestia gammarella*	Beach-flea	Stevens (1997)
	Amphipoda	*Orchestia grillus*	Beach-flea	Stevens (1997)
	Amphipoda	*Gammarus oceanicus*		Gratto ('86), Stevens ('97)
	Cirripedia	*Semibalanus balanoides*	Barnacle	Thomas & Page ('83), Stevens ('97)
	Cirripedia	*Balanus crenatus*	Barnacle	MacKay ('75), Stevens ('97)
	Cirripedia	*Balanus improvisus*	Barnacle	MacKay (1975)
	Decapoda	*Crangon septemspinosa*	Sand Shrimp	Gratto (1986)
	Decapoda	*Carcinus maenas*	Green Crab	Gratto ('86), Stevens ('97)
	Decapoda	*Homarus americanus*	American Lobster	MacKay (1975)
	Mysidacea	*Mysis stenolepis*	Mysid shrimp	Gratto (1986)
Insecta	Arachnida	*Pentaneura philippi*		Stevens (1997)
	Arachnida	*Halacarus* sp.	Mite	Stevens (1997)
	Diptera	Tabanidae pupae and larvae	Insect larvae	Gratto (1986)
	Diptera	Tipulidae larvae	Insect larvae	Gratto (1986)
	Diptera	Chironomidae pupae and larvae	Insect larvae	Gratto (1986)
	Hemiptera	Corixidae		Gratto (1986)
Gastropoda	Hydrobiidae	*Hydrobia minuta (H. totteni)*		Gratto ('86), Stevens ('97)
	Lacunidae	*Lacuna vincta*	Chink shell	Thomas & Page ('83), Stevens ('97)
	Littorinidae	*Littorina littorea*	Common Periwinkle	Gratto ('86), Stevens ('97)
	Littorinidae	*Littorina obtusata*	Smooth Periwinkle	MacKay ('75), Stevens ('97)
	Littorinidae	*Littorina saxatilis*	Rough Perimwnkle	MacKay ('75), Stevens ('97)
	Muricidae	*Nucella (Thias) lapillus*	Atlantic Dog Whelk	Thomas & Page ('83), Stevens ('97)
	Acmaeidae	*Collisella (Acmaea) testudinalis*	Tortise-shell (Atl. plate) Limpet	Thomas & Page ('83), Stevens ('97)
	Nassariidae	*Nassarius trivittatus*	New England dog whelk	Wildish ('83), Stevens ('97)
	Naticidae	*Lunatia heros*	Common Nor. Moon-shell	Wildish ('83)
	Buccinidae	*Buccinum undatum*	Waved or Edible Whelk	Stevens (1997)
	Trochidae	*Margarites groenlandica*	Green Margarite	Stevens (1997)
	Aeolidiidae	*Aeolidia papillosa*	Papillose Eolis	Stevens (1997)
	Dendronotidae	*Dendronotus frondosus*	Frond Eolis	Stevens (1997)
	Lamellidoridiidae	*Adalaria proxima*		Stevens (1997)
	Lamellidoridiidae	*Onchidoris asperse*		Stevens (1997)
	Sekeneopsidae	*Skeneopsis planorbis*		Stevens (1997)
Bivalvia	Pelecypoda	*Macoma balthica*	Little Macoma	Gratto ('86), Stevens ('97)
	Pelecypoda	*Nucula delpdinodonta*	Nut shell	Wildish (1983)
	Pelecypoda	*Mya arenaria*	Soft-shelled Clam	Gratto ('86), Stevens ('97)
	Pelecypoda	*Mytilus edulis*	Blue/Edible Mussel	MacKay ('75), Stevens ('97)
	Pelecypoda	*Modiolus modiolus*	Red/Horse mussel	Stevens (1997)
	Pelecypoda	*Musculus discors*	Discordant Mussel	Stevens (1997)
	Pelecypoda	*Hiatella arctica*	Arctic Saxicave	Stevens (1997)
	Pelecypoda	*Anomia simplex*	Smooth Jingle Shell	Stevens (1997)
	Pelecypoda	*Placopectin magellanicus*	Giant Sea Scallop	MacKay (1975)
	Polyplacophora	*Ischnochiton ruber*	Northern Red Chiton	Stevens (1997)
	Polyplacophora	*Tonicella marmorea*	Mottled Red Chiton	Stevens (1997)
Chaetognatha	Chaetognatha	*Sagitta* sp.	Arrow Worm	Gratto (1986)
Echinodermata	Asteroidea	*Asterias vulgaris*	Purple starfish	Singh (per. obs.), Stevens ('97)
	Asteroidea	*Asterias forbesii*	Intertidal Starfish	Singh (per. obs.), Stevens ('97)
	Asteroidea	*Leptasterias littoralis*		Stevens (1997)
	Echinoidea	*Strongylocentrotus droebachiensis*	Green Sea Urchin	Stevens (1997)
	Ophiuroidea	*Ophiopholis aculeata*	Daisy Brittlestar	Stevens (1997)
	Holothuroidea	*Psolus fabricii*	Sole-Footed sea cucumber	Singh (per. obs.), Stevens ('97)
	Holothuroidea	*Cucumaria frondosa*	Large Northern sea cucumber	Stevens (1997)
Hemicordata	Enteropneusta	*Saccoglossus kowalewskyi*	Acorn Worm	MacKay ('75), Stevens ('97)
Urochordata	Ascidiacea	*Ascidia callosa*	Tunicate	Stevens (1997)
	Ascidiacea	*Mogula citrina*	Tunicate	Stevens (1997)
FISHES	Cyclopteridae	*Cyclopterus lumpus*	Lumpfish	Gratto (1986)
	Clupeidae	*Clupea harengus*	Herring	Gratto (1986)
	Clupeidae	*Alosa aestivalis*	Blueback herring	Gratto (1986)
	Clupeidae	*Alosa pseudoharengus*	Gaspereau	Gratto (1986)
	Clupeidae	*Alosa sapidissima*	Shad	Gratto (1986)
	Salmonidae	*Salvelinus fontinalis*	Brook trout	Gratto (1986)
	Osmeridae	*Osmerus mordax*	Smelt	Gratto (1986)
	Angullidae	*Angullia rostrata*	Eel	Gratto (1986)
	Cyprinodontidae	*Fundulus heteroclitus*	Mummichog	Gratto ('86), Stevens ('97)
	Cyprinodontidae	*F. diaphanus*	Banded killifish	Gratto (1986)
	Gadidae	*Microgadus tomcod*	Tomcod	Gratto (1986)
	Gadidae	*Pollachius virens*	Pollock	Gratto ('86), Stevens ('97)
	Gadidae	*Urophycis chuss*	Squirrel hake	Gratto (1986)
	Pleuronectidae	*Limanda ferruginea*	Yellowtail flounder	Gratto (1986)
	Pleuronectidae	*Pseudopleuronectes americanus*	Winter flounder	Gratto (1986)
	Pleuronectidae	*Liopsetta putnami*	Smooth flounder	Gratto (1986)
	Atherinidae	*Menidia menidia*	Silverside	Gratto (1986)
	Gasterecsteidae	*Pungitius pungitius*	Nine-spined stickleback	Gratto (1986)
	Gasterecsteidae	*Gasterosteus aculeatus*	Three-spined stickleback	Gratto ('86), Stevens ('97)
	Cottidae	*Myoxocephalus scorpius*	Sculpin	Gratto ('86), Stevens ('97)
	Cottidae	*Hemitripterus americanus*	Sea raven	Gratto (1986)

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	Zoarcidae	*Macrozoarces americanus*	Wrymouth	Gratto (1986)
	Pholidae	*Pholis gunnellus*	Rock gunnel	Stevens (1997)
BIRDS	Scolopacidae	*Squatarola squatarola*	*Black-bellied plover	Gratto (1986), Deichmann('99)
*=obs. in 1999	Scolopacidae	*Totanus melanoleuca*	*Greater yellowlegs	Gratto (1986), Deichmann('99)
	Scolopacidae	*Erolia minutilla*	*Least sandpiper	Gratto (1986), Deichmann('99)
	Scolopacidae	*Crocethia alba*	Sanderling	Gratto (1986)
	Scolopacidae	*Charadris hiaticula semipalmatus*	*Semipalmated plover	Gratto (1986), Deichmann('99)
	Scolopacidae	*Ereunetes pusillus*	*Semipalmated sandpiper	Gratto (1986), Deichmann('99)
	Scolopacidae	*Limnodromus griseus*	*Short-billed dowitcher	Gratto (1986), Deichmann('99)
	Scolopacidae	*Catoptrophorus semipalmatus*	Willet	Gratto (1986)
	Fringillidae	*Spizella arborea arborea*	*American (Eastern?) Tree Sparrow	Deichmann('99)
	Ardeidae	*Botaurus lentiginosus*	*American Bittern	Deichmann('99)
	Anatinae	*Anas rubripes*	*American Black Duck	Deichmann('99)
	Rallidae	*Fulica americana*	American Coot (Coot?)	Deichmann('99)
	Corvidae	*Corvus brachyrhynchos?*	*American Crow	Deichmann('99)
	Falconinae	*Falco sparverius*	American Kestrel	Deichmann('99)
	Parulidae	*Setophaga ruticilla*	*American Redstart	Deichmann('99)
	Turdidae	*Turdus migratorius*	*American Robin	Deichmann('99)
	Anatinae	*Mareca americana*	*American Widgeon (Baldpate?)	Deichmann('99)
	Scolopacidae	*Philohela minor*	*American Woodcock	Deichmann('99)
	Sterninae	*Sterna paradisaea*	Arctic Tern	Deichmann('99)
	Alcidae	*Fratercula arctica arctica*	Atlantic Puffin	Deichmann('99)
	Scolopacidae	*Erolia bairdii*	Baird's Sandpiper	Deichmann('99)
	Buteoninae	*Haliaeetus leucocephalus*	*Bald eagle	Deichmann('99)
	Itercidae	*Icterus galbula*	Baltimore Oriole	Deichmann('99)
	Hirundinidae	*Riparia riparia riparia*	*Bank Swallow	Deichmann('99)
	Hirundinidae	*Hirundo rustica erthrogaster*	*Barn Swallow	Deichmann('99)
	Strigidae/Tytonidae	*Strix varia*	*Barred Owl	Deichmann('99)
	Parulidae	*Dendroica castanea*	Bay-breasted Warbler	Deichmann('99)
	Alcedinidae	*Megaceryle alcyon alcyon*	*Belted Kingfisher	Deichmann('99)
	Parulidae	*Mniotilta varia*	*Black & White Warbler	Deichmann('99)
	Alcidae	*Cepphus grylle*	*Black Guillemot	Deichmann('99)
	Sterninae	*Chlidonias nigra surinamensis*	Black Tern	Deichmann('99)
	Picidae	*Picoides arcticus*	Black-backed Woodpecker	Deichmann('99)
	Cuculidae	*Coccyzus erthrophthalmus*	Black-billed Cuckoo	Deichmann('99)
	Parulidae	*Dendroica fusca*	Black-burnian Warbler	Deichmann('99)
	Paridae	*Parus atricapillus*	*Black-capped Chickadee	Deichmann('99)
	Aredidae	*Nycticorax nycticorax hoactli*	Black-crowned Night Heron	Deichmann('99)
	Larinae	*Rissa tridactyla tridactyla*	Black-legged Kittiwake	Deichmann('99)
	Parulidae	*Dendroica striata*	Blackpoll Warbler	Deichmann('99)
	Parulidae	*Dendroica coerulescens*	Black-thr. Blue Warbler	Deichmann('99)
	Parulidae	*Dendroica virens*	*Black-thr. Green Warbler	Deichmann('99)
	Corvidae	*Cyanocitta cristata*	*Blue Jay	Deichmann('99)
	Anatinae	*Anas discors*	*Blue-winged Teal	Deichmann('99)
	Icteridae	*Dolichonyx oryzivorus*	*Bobolink	Deichmann('99)
	Larinae	*Larus philadelphia*	*Bonaparte's Gull	Deichmann('99)
	Paridae	*Parus hudsonicus*	*Boreal Chickadee	Deichmann('99)
	Anserinae	*Branta bernicla*	Brant	Deichmann('99)
	Buteoninae	*Buteo platypterus platypterus*	*Broad-winged Hawk	Deichmann('99)
	Certhiidae	*Certhia familiaris*	Brown Creeper	Deichmann('99)
	Itercidae	*Molothrus ater ater*	*Brown-headed (Eastern?) Cowbird	Deichmann('99)
	Scolopacidae	*Tryngites subruficollis*	*Buff-breasted Sandpiper	Deichmann('99)
	Aythyinae	*Glaucionetta albeola*	Buffle-head	Deichmann('99)
	Anserinae	*Branta canadensis*	*Canada Goose	Deichmann('99)
	Parulidae	*Wilsonia canadensis*	*Canada Warbler	Deichmann('99)
	Parulidae	*Dendroica tigrina*	*Cape May Warbler	Deichmann('99)
	Sterninae	*Hydroprogne caspia*	Caspian Tern	Deichmann('99)
	Ardeidae	*Bubulcus ibis*	Cattle Egret	Deichmann('99)
	Bombycillidae	*Bombycilla cedrorum*	*Cedar Waxwing	Deichmann('99)
	Parulidae	*Dendroica pensylvanica*	*Chestnut-sided Warbler	Deichmann('99)
	Fringillidae	*Spizella passerina passerina*	*(Eastern?) Chipping Sparrow	Deichmann('99)
	Hirundinidae	*Petrochelidon pyrrhonoto albifrons*	*(Northern) Cliff Swallow	Deichmann('99)
	Larinae	*Larus ridibundus ridibundus*	Co. Black-headed Gull	Deichmann('99)
	Aythyinae	*Somateria mollissima*	*Common Eider	Deichmann('99)
	Aythyinae	*Glaucionetta clanguia americana?*	*Common (American?) Golden-eye	Deichmann('99)
	Iteridae	*Quiscalis quiscula*	*Common Grackle	Deichmann('99)
	Gaviidae	*Gavia immer*	*Common Loon	Deichmann('99)
	Merginae	*Mergus merganser americanus*	*(American?) Common Merganser	Deichmann('99)
	Rallidae	*Gallinula chloropus*	Common Moorhen	Deichmann('99)
	Alcidae	*Uria aagle aagle*	Common Murre	Deichmann('99)
	Caprimulgidae	*Chordeiles minor*	*Common Nighthawk	Deichmann('99)
	Corvidae	*Corvus corax*	*Common Raven	Deichmann('99)
	Fringillidae	*Acanthis flammea*	*Common Redpoll	Deichmann('99)
	Scolopacidae	*Capella gallinago*	Common Snipe	Deichmann('99)
	Sterninae	*Sterna hirundo hirundo*	*Common Tern	Deichmann('99)
	Parulidae	*Geothlypis trichas?*	*Common Yellowthroat	Deichmann('99)
	Fringillidae	*Junco hyemalis*	*Dark-eyed (Northern) Junco	Deichmann('99)
	Phalacrocoracidae	*Phalacrocorax auritus*	*Double-crested Cormorant	Deichmann('99)
	Alcidae	*Plautus alle alle*	Dovekie	Deichmann('99)
	Picidae	*Dendrocopus borealis*	*Downy Woodpecker	Deichmann('99)
	Scolopacidae	*Erolia alpina arctica*	Dunlin	Deichmann('99)
	Tyrannidae	*Contopus virens*	*E. Wood Pewee	Deichmann('99)
	Tyrannidae	*Tyrannus tyrannus*	*Eastern Kingbird	Deichmann('99)
	Icteridae	*Sturnella neglecta*	Eastern Meadowlark	Deichmann('99)
	Tyrannidae	*Sayornis phoebe*	*Eastern Phoebe	Deichmann('99)
	Sturnidae	*Sturnus vulgaris vulgaris?*	*European Starling	Deichmann('99)
	Fringillidae	*Hesperiphona vespertina*	*Evening (Eastern?) Grosbeak	Deichmann('99)
	Fringillidae	*Passerella iliaca iliaca*	*(Eastern?) Fox Sparrow	Deichmann('99)
	Anatinae	*Anas strepera*	Gadwall	Deichmann('99)
	Larinae	*Larus hyperboreus hyperboreus*	Glaucous Gull	Deichmann('99)
	Sylviidae	*Regulus satrapa satrapa*	*Golden-crowned Kinglet	Deichmann('99)
	Mimidae	*Dumetella carolinensis?*	*Gray Catbird	Deichmann('99)
	Corvidae	*Perisoreus canadensis?*	*(Canada?) Gray Jay	Deichmann('99)
	Turdidae	*Hylocichla ustulata*	Gray-cheeked Thrush	Deichmann('99)
	Larinae	*Larus marinus*	*Great Black-backed Gull	Deichmann('99)
	Ardeidae	*Ardea herodias*	*Great Blue Heron	Deichmann('99)
	Phalacrocoracidae	*Phalacrocorax carbo carbo?*	*Great Cormorant	Deichmann('99)
	Tyrannidae	*Myiarchus crinitus*	Great Crested Flycatcher	Deichmann('99)
	Ardeidae	*Casmerodius albus*	Great Egret	Deichmann('99)
	Strigidae/Tryonidae	*Bubo virginianus*	*Great Horned Owl	Deichmann('99)
	Aythyinae	*Aythya marila nearctica*	*Greater Scaup	Deichmann('99)

Phylum	Class/Family	Species name	Common Name	Reference
	Procellariidae	*Puffinus therminieri*	Greater Shearwater	Deichmann('99)
	Ardeidae	*Butorides virescens virescens?*	Green-backed Heron	Deichmann('99)
	Anatinae	*Anas carolinensis*	*Green-winged Teal	Deichmann('99)
	Falconinae	*Falco rusticolus obsoletus*	*Gyrfalcon	Deichmann('99)
	Picidae	*Dendrocopus villosus*	*Hairy Woodpecker	Deichmann('99)
	Aythyinae	*Histrionicus histrionicus*	Harlequin Duck	Deichmann('99)
	Turdidae	*Hylocichla guttata faxoni*	*(Eastern) Hermit Thrush	Deichmann('99)
	Larinae	*Larus argentatus*	*Herring Gull	Deichmann('99)
	Fringillidae	*Acanthis hornemanni exilipes*	Hoary Redpoll	Deichmann('99)
	Merginae	*Lophodytes cucullatus*	*Hooded Merganser	Deichmann('99)
	Colymbidae	*Colymbus auritus*	Horned Grebe	Deichmann('99)
	Alaudidae	*Eremophilia alpestris*	*Horned Lark	Deichmann('99)
	Fringillidae	*Carpodacus mexicanus*	House Finch	Deichmann('99)
	Ploceidae	*Passer domesticus domesticus*	House (English) Sparrow	Deichmann('99)
	Scolopacidae	*Limosa hoemastica*	Hudsonian Godwit	Deichmann('99)
	Larinae	*Larus leucopterus*	*Iceland Gull	Deichmann('99)
	Fringillidae	*Passerina cyanea*	Indigo Bunting	Deichmann('99)
	Charadriidae	*Charadrius vociferus vociferus*	*Killdeer	Deichmann('99)
	Aythyinae	*Somateria spectabilis*	King Eider	Deichmann('99)
	Fringillidae	*Calcarius lapponicus lapponicus*	Lapland Longspur	Deichmann('99)
	Larinae	*Larus atricilla*	*Laughing Gull	Deichmann('99)
	Hydrobatidae	*Oceanodroma leucorhoa leucorhoa*	Leach's Storm Petrel	Deichmann('99)
	Tyrannidae	*Empidonax minimus*	*Least Flycatcher	Deichmann('99)
	Larinae	*Larus fuscus*	Lesser Black-backed Gull	Deichmann('99)
	Scolopacidae	*Pluvialis dominica*	(American?) Lesser Golden Plover	Deichmann('99)
	Aythyinae	*Aythya affinis*	Lesser Scaup	Deichmann('99)
	Scolopacidae	*Totanus flavipes*	Lesser Yellowlegs	Deichmann('99)
	Fringillidae	*Melospiza lincolnii lincolnii*	*Lincoln's Sparrow	Deichmann('99)
	Larinae	*Larus minutus*	Little Gull	Deichmann('99)
	Strigidae/Tytonidae	*Asio otus wilsonianus*	Long-eared Owl	Deichmann('99)
	Anatinae	*Anas platyrhynchos platyrhynchos*	*Mallard	Deichmann('99)
	Parulidae	*Dendroica magnolia*	*Magnolia Warbler	Deichmann('99)
	Tryglodytidae	*Cistothorus platensis stellaris?*	(Short-billed?) Marsh Wren	Deichmann('99)
	Falconinae	*Falco columbarius*	*Merlin	Deichmann('99)
	Columbidae	*Zenaidura macroura*	*Mourning Dove	Deichmann('99)
	Parulidae	*Oporornis philadelphia*	*Mourning Warbler	Deichmann('99)
	Parulidae	*Vermivora ruficapilla ruficapilla*	*Nashville Warbler	Deichmann('99)
	Fringillidae	*Ammospiza caudacuta nelsoni*	*Nelson's Sharp-tailed Sparrow	Deichmann('99)
	Fringillidae	*Richmondena cardianlis*	Nor. Cardinal	Deichmann('99)
	Parulidae	*Parula americana*	*Nor. Parula (Warbler)	Deichmann('99)
	Strigidae/Tytonidae	*Aegolius acadica acadica*	Nor. Saw-whet Owl	Deichmann('99)
	Picidae	*Picoides tridactylus bacatus*	Nor. Three-toed Woodpecker	Deichmann('99)
	Antinae	*Spatula clypeata*	Northen Shoveler	Deichmann('99)
	Picidae	*Colaptes auratus luteus*	*Northern Flicker	Deichmann('99)
	Procellariidae	*Fulmarus glacialis*	Northern Fulmar	Deichmann('99)
	Sulidae	*Morus bassanus*	*Northern Gannet	Deichmann('99)
	Accipitrinae	*Accipiter gentilis atricapillus?*	*Northern Goshawk	Deichmann('99)
	Circinae	*Circus cyaneus hudsonius*	*Northern Harrier	Deichmann('99)
	Strigidae/Tytonidae	*Surnia ulula caparoch*	Northern Hawk Owl	Deichmann('99)
	Anatinae	*Anas acuta tzitzihoa?*	*Northern Pintail	Deichmann('99)
	Laniidae	*Lanius excubitor borealis*	Northern Shrike	Deichmann('99)
	Parulidae	*Seiurus noveboracensis noveboracensis*	*Northern Waterthrush	Deichmann('99)
	Aythyinae	*Clangula hyemalis*	Oldsquaw	Deichmann('99)
	Tyrannidae	*Nuttallornis borealis*	Olive-sided Flycatcher	Deichmann('99)
	Pandionidae	*Pnadion haliaetus carolinensis*	*Osprey	Deichmann('99)
	Parulidae	*Seiurus aurocapillus*	*Oven-bird	Deichmann('99)
	Parulidae	*Dendroica palmarum*	*Palm Warbler	Deichmann('99)
	Scolopacidae	*Erolia melanotos*	Pectoral Sandpiper	Deichmann('99)
	Falconinae	*Falco peregrinus*	*Peregrine Falcon	Deichmann('99)
	Colymbidae	*Podilymbus podiceps podiceps*	*Pied-billed Grebe	Deichmann('99)
	Picidae	*Hylatomus pileatus*	Pileated Woodpecker	Deichmann('99)
	Fringillidae	*Pinicola enucleator leucura*	*(Canadian?) Pine Grosbeak	Deichmann('99)
	Fringillidae	*Spinus pinus pinus*	*Pine Siskin	Deichmann('99)
	Charadriidae	*Charadrius melodus*	*Piping Plover	Deichmann('99)
	Fringillidae	*Carpodacus purpureus purpureus*	*Purple Finch	Deichmann('99)
	Scolopacidae	*Erolia maritima*	*Purple Sandpiper	Deichmann('99)
	Alcidae	*Alca torda torda?*	Razorbill (Razor-billed Auk?)	Deichmann('99)
	Fringillidae	*Loxia curvirostra*	Red Crossbill	Deichmann('99)
	Scolopacidae	*Calidris canutus tufus*	Red Knot	Deichmann('99)
	Phalaropodidae	*Phalaropus fulicarius*	Red Phalarope	Deichmann('99)
	Merginae	*Mergus serrator*	*Red-breasted Merganser	Deichmann('99)
	Sittidae	*Sitta canadensis*	*Red-breasted Nuthatch	Deichmann('99)
	Vireonidae	*Vireo olivaceus*	*Red-eyed Vireo	Deichmann('99)
	Picidae	*Colymbus grisegena holboll?*	Red-necked Grebe	Deichmann('99)
	Phalaropodidae	*Lobipes lobatus*	Red-necked Phalarope (Northern)	Deichmann('99)
	Buteoninae	*Buteo jamaicensis*	*Red-tailed Hawk	Deichmann('99)
	Gaviidae	*Gavia stellata*	*Red-throated Loon	Deichmann('99)
	Iteridae	*Agelaius phoeniceus?*	*Red-winged Blackbird	Deichmann('99)
	Larinae	*Larus delawarensis*	*Ring-billed Gull	Deichmann('99)
	Aythyinae	*Aythya collaris*	*Ring-necked Duck	Deichmann('99)
	Columbidae	*Columba livia*	*Rock Dove or Domestic Pigeon	Deichmann('99)
	Sterninae	*Sterna dougallii dougallii*	Roseate Tern	Deichmann('99)
	Fringillidae	*Pheucticus ludovicianus*	*Rose-breasted Grosbeak	Deichmann('99)
	Buteoninae	*Buteo lagopus s. johannis*	*Rough-legged Hawk	Deichmann('99)
	Sylviidae	*Regulus calendula calendula*	*Ruby-crowned Kinglet	Deichmann('99)
	Trochilidae	*Archilochus colubris*	*Ruby-throated Hummingbird	Deichmann('99)
	Erismaturinae	*Erismatura jamaicensis rubida*	Ruddy Duck	Deichmann('99)
	Charadriidae	*Arenaria interpres morinella*	Ruddy Turnstone	Deichmann('99)
	Tetraonidae	*Bonasa umbellus*	*Ruffled Grouse	Deichmann('99)
	Fringillidae	*Pipilo erythrophthalmus*	Rufous-sided Towhee	Deichmann('99)
	Icteridae	*Euphagus carolinus*	*Rusty Blackbird	Deichmann('99)
	Fringillidae	*Passerculus sandwichensis*	*Savannah Sparrow	Deichmann('99)
	Thraupidae	*Piranga olivacea*	Scarlet Tanager	Deichmann('99)
	Tryglodytidae	*Troglodytes aedon?*	Sedge (House?) Wren	Deichmann('99)
	Accipitrinae	*Accipiter striatus velox*	*Sharp-shinned Hawk	Deichmann('99)
	Strigidae/Tytonidae	*Asio flammeus flammeus*	Short-eared Owl	Deichmann('99)
	Fringillidae	*Plectrophenax nivalis nivalis*	*Snow Bunting	Deichmann('99)
	Anserinae	*Chen hyperborea*	Snow Goose	Deichmann('99)
	Ardeidae	*Leucophoyx thula thula*	Snowy Egret	Deichmann('99)
	Strigidae/Tytonidae	*Nyctea scandiaca*	Snowy Owl	Deichmann('99)
	Scolopacidae	*Tringa solitaria solitaria*	Solitary Sandpiper	Deichmann('99)

Phylum	Class/Family	Species name	Common Name	Reference
	Vireonidae	*Vireo solitarius*	*Solitary (Blue-Headed?) Vireo	Deichmann('99)
	Fringillidae	*Melospiza melodia*	*Song Sparrow	Deichmann('99)
	Rallidae	*Porzana carolina*	*Sora	Deichmann('99)
	Scolopacidae	*Actitis macularia*	*Spotted Sandpiper	Deichmann('99)
	Tetraonidae	*Canachites canadensis*	*Spruce Grouse	Deichmann('99)
	Scolopacidae	*Micropalama himantopus*	*Stilt Sandpiper	Deichmann('99)
	Aythyinae	*Melanitta perspicillata*	*Surf Scoter	Deichmann('99)
	Turdidae	*Catharus guttatus*	*Swainson's Thrush	Deichmann('99)
	Fringillidae	*Melospiza georgiana*	*Swamp Sparrow	Deichmann('99)
	Parulidae	*Vermivora peregrina*	*Tennessee Warbler	Deichmann('99)
	Alcidae	*Alca torda torda?*	Thick-billed Murre	Deichmann('99)
	Hirundinidae	*Iridoprocne bicolor*	*Tree Swallow	Deichmann('99)
	Catharidae	*Cathartes aura*	Turkey Vulture	Deichmann('99)
	Scolopacidae	*Bartramia longicauda*	Upland Sandpiper	Deichmann('99)
	Turdidae	*Hylocichla fuscescens*	*Veery	Deichmann('99)
	Fringillidae	*Pooecetes gramineus gramineus*	(Eastern?) Vesper Sparrow	Deichmann('99)
	Rallidae	*Rallus limicola limicola*	Virgina Rail	Deichmann('99)
	Motacillidae	*Anthus spinoletta rubescens?*	*Water (American?) Pipit	Deichmann('99)
	Scolopacidae	*Ereunetes mauri*	Western Sandpiper	Deichmann('99)
	Scolopacidae	*Numenius arquata arquata*	Whimbrel	Deichmann('99)
	Fringillidae	*Zonotrichia leucophyrs*	White-crowned Sparrow	Deichmann('99)
	Scolopacidae	*Erolia fuscicollis*	White-rumped Sandpiper	Deichmann('99)
	Fringillidae	*Zonotrichia albicollis*	*White-throated Sparrow	Deichmann('99)
	Fringillidae	*Loxia leucoptera leucoptera*	*White-winged Crossbill	Deichmann('99)
	Phalaropodidae	*Steganopus tricolor*	Wilson's Phalarope	Deichmann('99)
	Parulidae	*Wilsonia pusilla pusilla*	*Wilson's Warbler	Deichmann('99)
	Aythyinae	*Melanitta fusca deglandi*	*(White?)-Winged Scoter	Deichmann('99)
	Sterninae	*Troglodytes troglodytes*	*Winter Wren	Deichmann('99)
	Anatinae	*Aix sponsa*	*Wood Duck	Deichmann('99)
	Rallidae	*Coturnicops noveboracensis noveboracensis*	Yellow Rail	Deichmann('99)
	Parulidae	*Dendroica petechia*	*Yellow Warbler	Deichmann('99)
	Tyrannidae	*Empidonax flaviventris*	*Yellow-bellied Flycatcher	Deichmann('99)
	Parulidae	*Dendroica coronata*	*Yellow-rumped Warbler	Deichmann('99)
Mammals	Phocid	*Phoca vitulina*	Harbour Seals	Deichmann('99)
	Cervidae	*Odocoileus virginianus leucurus*	White-tailed Deer	Deichmann('99)
	Leporidae	*Lepus americanus*	Snowshow Hare	Deichmann('99)
	Erethizontidae	*Erethizon dorsatum*	Porcupine	Deichmann('99)
	Sciuridae	*Tamiasciurus hudsonicus*	Red Squirrels	Deichmann('99)